REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*: 15-06-2005

2. REPORT TYPE: Final Report

3. DATES COVERED *(From - To)*: July 2004 to July 2005

4. TITLE AND SUBTITLE

Analysis of Quantitative and Qualitative Benefits Associated With the Implementation of Omnicell

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Heidelberg MEDDAC
CMR 442
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

40-05

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT The purpose of this analysis was to analyze the quantitative and qualitative benefits associated with Omnicell implementation at HMEDDAC to determine whether purchasing the equipment was worth the investment and substantiate whether the program should be expanded. The quantitative benefits measured were cost avoidances and cost savings by individual clinical services. Qualitative benefits were discussed in relation to the following: supply consumption tracking, reporting and analysis, medication management, personnel time savings, and customer satisfaction. Based on the quantitative and qualitative benefits demonstrated in the analysis, the study concludes that purchasing the Omnicell equipment was worth the investment. Because of the Army's imminent realignment within Europe and HMEDDAC's projected reduction in services, the study does not recommend expansion of the program.

15. SUBJECT TERMS

supply automation; point-of-use in health care; hospital materials management; Omnicell; medical logistics management; medical supply chain management

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(include area code)*
U	U	U	UU	Total 92	Education Technician / (210) 221-6443

Running Head: ANALYSIS OF BENEFITS ASSOCIATED WITH OMNICELL

Analysis of Quantitative and Qualitative Benefits Associated With the Implementation of Omnicell

A Graduate Management Project

Submitted to the Faculty of

U.S. Army-Baylor University

by

CPT George J. Zeckler

June 2005

Acknowledgments

My graduate management project (GMP) could not have been completed without the support and assistance of so many people, only some of who are listed here. First and foremost, I am grateful to my Lord and Savior, Jesus Christ, who has made all things possible. My wife, Elizabeth, for her support throughout my didactic year and this entire residency year. She has been a blessing and marrying her was the best decision I ever made. My preceptor, LTC Wilhite, for his guidance and mentorship, for sharing his knowledge of healthcare administration, and for allowing me to focus on my residency and this GMP. He has led by example and I have learned much by observing his leadership style. My reader, LTC Salguiero for his assistance and direction. Major Lopiccolo (Logistics) for helping me in every aspect and every phase of this GMP. Several Logistics staff and medical warehouse personnel for assisting me with data collection, specifically Mrs. Melanie Mosher, Mr. Chandrika Pilapitiya, Mr. Andreas Steisslinger, and SGT Vanessa Kennedy. MAJ Kelly Thomson (Resource Management) and CSM Frances Rivera for assisting me with technical aspects of this GMP. SGT Keith DeLeeuw (PAD) for providing me all of the workload data used in this GMP. Other colleagues who provided me with useful information, SSG Robert Zuch (Pharmacy), SFC Galen Stilwell (OR), Ms. Pam Haas (ERMC Logistics), MAJ Alice LeDoux-Abraham and Mr. Steve Engle (ERMC PAD). Last but most definitely not least, Mr. Grant Canfield (Omnicell Consultant) for the unconditional and timely assistance he provided, for giving me an understanding of the reporting and analysis tools Omnicell provides, and assisting me with data analysis utilized in the successful completion of this GMP. And to the others who provided assistance, Thank You!

Abstract

The purpose of this analysis was to analyze the quantitative and qualitative benefits associated with Omnicell implementation at HMEDDAC to determine whether purchasing the equipment was worth the investment and substantiate whether the program should be expanded. The quantitative benefits measured were cost avoidances and cost savings by individual clinical services. Qualitative benefits were discussed in relation to the following: supply consumption tracking, reporting and analysis, medication management, personnel time savings, and customer satisfaction. Based on the quantitative and qualitative benefits demonstrated in the analysis, the study concludes that purchasing the Omnicell equipment was worth the investment. Because of the Army's imminent realignment within Europe and HMEDDAC's projected reduction in services, the study does not recommend expansion of the program.

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The supply chain management (SCM) problems encountered by Heidelberg MEDDAC (HMEDDAC) necessitated a more efficient system. HMEDDAC's supply management was ineffective. The hospital's clinics and services did not have a clear system of ordering supplies, and true consumption of supplies was not known. The inventory management section of Logistics was unaware of inventory levels within HMEDDAC; however, it was clear that superfluous amounts of inventory were present. The lack of demand history and the unawareness of true supply consumption caused ineffective supply management and a lack of supply accountability. Because a large portion of operating expenses is consumed on medical supplies, HMEDDAC's ineffective supply management was an important issue to resolve. Understanding that purchasing and installing supply automation equipment within the hospital was necessary to more effectively manage supplies within HMEDDAC, the hospital purchased and installed Omnicell's automated point-of-use (POU) equipment to employ just-in-time (JIT) inventory management principles and improve operational efficiencies.

The purpose of this study is to determine whether purchasing the Omnicell equipment was worth the investment and substantiate whether the program should be expanded further within HMEDDAC. Specifically, the study conducts an analysis of the quantitative and qualitative benefits Omnicell implementation has provided HMEDDAC. The quantitative benefits that will be measured are cost avoidances and cost savings by individual clinical services as a result of Omnicell implementation. The qualitative benefits that will be discussed include the following variables: supply consumption tracking, reporting and analysis capabilities, medication management and patient safety, personnel time savings, customer satisfaction. The implications of this analysis will be used to conclude whether purchasing the Omnicell equipment was worth the investment and whether the program should be expanded further within HMEDDAC

Background

The United States Army Medical Department Activity in Heidelberg, Germany, (USAMH or HMEDDAC) is a 63-bed facility located within the German state of Bȧden-Wurttemburg. The HMEDDAC began its operations here as the 130th Station Hospital in July 1945. Today, its services include inpatient and outpatient care. Its outpatient services include: emergency care, pediatrics, internal medicine, optometry, family practice, dermatology, ophthalmology, obstetrics and gynecology, psychiatric, social work, respiratory therapy, general surgery, orthopaedic, physical therapy, occupational therapy, and occupational health. Its inpatient care consists of the labor and delivery and medical-surgical wards. The hospital's ancillary services include laboratory, radiology, and inpatient and outpatient pharmacies. The HMEDDAC also maintains four functional operating rooms. In addition to the ten building complex in Heidelberg, the hospital operates nine outpatient clinics in military installations located in Buedingen, Butzbach, Babenhausen, Coleman, Darmstadt, Friedburg, Hanau, Mannheim, and Stuttgart. This combined healthcare delivery system supports over 68,000 beneficiaries spread over 6,200 miles throughout central Germany. Until recently, a military construction project, with an allocation of $28.5 million, was set to begin in December, 2003; however, that project has been terminated. Consequently, HMEDDAC continues operating indefinitely in its current structures. When discussing and mentioning the "hospital" or

"HMEDDAC" in this paper, I am referring to the main hospital facility on the Nachrichten compound in Heidelberg, not inclusive of the outlying clinics.

As with every hospital within the Army Medical Command (MEDCOM), HMEDDAC has several areas of concern for which it must continuously maintain focus. Some of these concerns include: manpower shortages, data quality, its role in the Global War on Terrorism (GWOT), facility maintenance of its aging facilities, meeting TRICARE's access to care requirements for its beneficiary population, maintaining accreditation standards, and maintaining fiscal responsibility by operating within given resources and abiding by published budget guidelines and fiscal laws. Operating within budget guidelines is one of the most important areas of concern for the hospital, as it affects and is affected by the majority of the hospital's other areas of concern. Behind civilian and local national employee pay, supply expenses, primarily consisting of pharmaceuticals and medical supplies, account for the largest percentage of HMEDDAC's total operating expenses. Therefore, ensuring supply expenses are efficiently and effectively managed is fundamental to the hospital's success at operating within its stated budgetary guidelines.

Conditions That Prompted the Study

The supply chain consumes a major portion of a hospital's operating expenses. About 35% of the budgets of most hospitals and medical establishments are spent on inventories and supplies and the personnel to manage those inventories (Yasin, Wafa, & Small, 2004). Therefore, reduction in inventory cost has been a primary target for hospitals and health care administrators (Yasin et al., 2004). In 1999, one-third of U.S. hospitals had negative operating margins, and nearly two-thirds of U.S. hospitals will be losing money by the end of 2004 (Anonymous, 2002). Similar to the norm, HMEDDAC's supply costs, which include medical supplies and pharmaceuticals, accounted for almost 35% of its total operating budget in fiscal year 2004. In dollar figures, total supply expenditures were $14,856,973 out of a total operating budget of $43,010,100. With supply costs accounting for such a large percentage of the total operating budget, optimizing these resources is critical to maintaining financial viability. Because HMEDDAC is a government entity, it does not have the ability to simply raise prices and pass costs onto consumers as a means of mitigating expenses. Thus, effective resource utilization is essential. As one of the largest areas of spending in health care, supply costs and the supply chain have received substantial focus as an opportunity for savings (Anonymous, 2002). Most hospitals have an opportunity to reduce supply chain expenses by as much as 15% through internal initiatives, and realize a nearly 4% improvement in bottom-line performance (Davis, 2004). Redesigning and improving processes, such as supply chain management, and using information technology to focus on reducing costs is one approach to success (Anonymous, 2002).

The hospital industry is under increasing pressure to reduce costs (Rosen & Veral, 2002), and the Army Medical Department is no exception. Major A.J. Lopiccolo (personal communication, October 05, 2004), Chief, Logistics Division, USAMH, understands that efficient utilization of resources is essential in maintaining HMEDDAC's financial viability. Among numerous responsibilities, he is responsible for the supply chain management of HMEDDAC. This supply chain includes the materials management branch, which is responsible for medical-surgical supply items. Even though medical-surgical supply items account for only a small fraction of hospital costs, they can still add up to a substantial amount of money each year (Rosen & Veral, 2001). For this reason, Major Lopiccolo's top priority, since his arrival at HMEDDAC in June, 2003, has been to make HMEDDAC's medical supply chain management more efficient and effective.

After Major Lopiccolo's arrival to HMEDDAC, he spent a few months visiting every customer in the hospital. In this case, "customer" refers to each individual service who orders supplies. Some of the customers include: the operating room (OR), outpatient clinics, nursing wards, and emergency room (ER). After reviewing their supply ordering trends and performing visual assessments of their supply rooms, he concluded that HMEDDAC's supply chain management (SCM) system was in critical need of reengineering. He discovered several patterns of inefficiency and waste in the ordering, purchasing, and distributing of medical-surgical supplies. Specifically, customer supply rooms consistently maintained superfluous amounts of inventory. None of the customers had a true understanding of their usage or supply needs, and several customers ordered based on the available space on their shelves rather than verifiable need or demand. Ordering of supplies was performed by clinicians or non-logistics technicians who worked in the section. Therefore, several variations of inventory management were evident.

Clearly, the technique of choice for ordering supplies was a visual system of determining need. Since specific par levels (a three to five day supply of frequently used items; base stock level) had not been established, this method of ordering resulted in an average of 30 days of stock on hand for the overwhelming majority of items. This overage of stock is detrimental to the HMEDDAC's budget because the money tied up in this excess inventory reduces the hospital's working capital, prohibiting the hospital to utilize these funds for other competing demands and mission requirements. The worst case of over-ordering was the OR. The OR stockpiled to such an extent that they had more stored inventory on hand than did HMEDDAC's logistics warehouse. Major Lopiccolo discovered that he could not establish a verifiable demand history for any of his customers. As a result, no one understood what the customers truly needed or consumed, resulting in a lack of control of inventory across the board.

To exacerbate the problem of surplus inventory further, the annual budget cycle's close-out process at year end (which ends every September 30) customarily triggers the customers to order excessive amounts of inventory. Before Omnicell implementation, the budget process at year end was to shut down the customers' DMLSS ordering capabilities on September 1 and consolidate their supply budgets into one centralized budget under the control of the Resource Management Division, with centralized acquisition through the Logistics Division. Access for ordering and procuring supplies remained solely in the hands of the Logistics Division, and every individual request for supplies had to be approved by the Resource Management Division and subsequently purchased by the Logistics Division directly. As a result of this anticipated year-end process, customers purchased excessive amounts of inventory during the months of July and August to cover the months of September and October, the period without DMLSS ordering capabilities or individual supply budgets. Because the customers were unaware of true need and supply consumption patterns, they ordered much more inventory than would have been required for the months of September and October, resulting in surplus inventory compounded with the excess inventory that resulted from other supply management inefficiencies. With automated POU equipment that would reorder supplies based on specific re-order points, supplies would be replenished based on actual consumption throughout the entire budget cycle, mitigating the problem of year-end stockpiling.

During this time, each customer maintained a specific online catalog it would use to manually order from an automated system called the Defense Medical Logistics Standard Support (DMLSS) system. This online catalog maintains a list of the specific items the customer has the ability to order. It is customized specific to each customer by the hospital inventory manager. The DMLSS is an automated information system that works at every echelon of Department of Defense (DoD) as its standard medical logistics system. Among its numerous capabilities, DMLSS supports the military treatment facility (MTF) with functions of stock control, inventory management, ordering, procurement, sharing and transferring data within the DoD medical community through its web-based on-line internet and intranet capabilities, and Prime Vendor operations (MHS IT Programs, 2003). At the local level, HMEDDAC utilizes the system's electronic data interchange function to order medical-surgical supplies from the U.S. Army Medical Material Center, Europe (USAMMCE). The USAMMCE functions as the distribution center and prime vendor for HMEDDAC and almost 1,700 DoD customers in the European and Southwest Asia theater of operations, distributing nearly $200 million in medical supplies annually (Owens, 2004). Over 65% of medical-surgical items ordered during this period by HMEDDAC were purchased from USAMMCE.

Within HMEDDAC, the catalog listings for each customer were controlled by the hospital's logistics inventory manager. Because the process of stock replenishment was not performed by the logisticians, the medical warehouse was not used effectively. Its main role was that of receiving the incoming supplies ordered by the customer and then notifying the customer when their supplies had arrived. The customer then went down to the warehouse, found his supplies loaded on a cart, and transported the supplies to his supply room. Another problem with this type of ordering system is that it requires the non-logistics trained clinicians or technicians to have an understanding of the DMLSS unit of issue (UI) for each item on their catalog. Previous to the implementation of Omnicell, the DMLSS unit of issue was the minimum quantity for which an item was ordered by and issued to the customer. The units of issue were shown on the customer's DMLSS online catalog. Since these units of issue were not broken down to their lowest level, the average medical-surgical item would be ordered by the case instead of by the "eaches." A customer's failure to understand the unit of issue for each item could lead to undesirable inventory levels for the customer. An example of an error that can occur with the misunderstanding of units of issue took place when a customer attempted to order 40 syringes but did not realize that the order was actually placed for 40 boxes of syringes. Regrettably, the mistake was not caught by the inventory manager before the order was processed through USAMMCE. Since excess inventory cannot be returned to USAMMCE for credit, mistakes similar to this one can have a detrimental impact on a customer's budget and the hospital.

Because true consumption of supplies was not known, a clear lack of accountability and effective systems for managing supply expenditures on the part of the customers was evident. Some customers cited that they stockpiled because they feared a stockout (a zero balance of a specific item) that might never materialize; nevertheless, they were unaware of the usage patterns of their supplies. It was not evident that there was uncertainty in replenishment; yet there was a surplus of safety stock, dead inventory that was not being used, duplication of stock in multiple storage areas, and the presence of "unofficial" inventory outside of some supply rooms. This surplus of inventory causes difficulty with properly forecasting budgets for customers. Additionally, these excess expenditures do not allow the capital expended for these excess supplies to fund HMEDDAC's other operating requirements, consequently impairing the overall mission of the hospital.

Ordering and dispensing of pharmaceuticals was also a cause of concern in this facility. The customers who had access to order pharmaceuticals, for example, the OR, ER, nursing wards, anesthesia, general surgery, and family practice, would order via the Composite Health Care System (CHCS). The CHCS is the primary automated medical information system for the DoD. It provides availability and reliability to 300,000 users worldwide, and it is used in over 700 DoD hospitals and clinics worldwide. Its capabilities include patient administration, laboratory, pharmacy, and radiological order entry, patient scheduling, workload reporting, and provider schedule managing functions (Lasell & Patterson, 2003). It also has the capability for itemized billing of supplies and pharmaceuticals to a patient, and will soon be the platform for the electronic medical record with its successor, CHCS II. The hospital's pharmacy is responsible for assigning access to specific customer personnel. For example, nurses perform the ordering function for HMEDDAC's wards. As seen in the medical-surgical supply chain, these clinical personnel who are performing the ordering function are not trained in how to manage inventory levels. These customers perform visual inventory of pharmaceuticals and order in quantities they "think" they need.

Because these customers maintained excessive levels of inventory of their pharmaceuticals, demand history and true consumption was virtually impossible to determine. Additionally, the unit of issue in the CHCS system was in vials, instead of being broken down to milliliters. Therefore, even if the vial could be used for multiple doses, excessive ordering resulted from the inability of CHCS to break down the unit of issue to its lowest level. After the customer inputs the resupply order, pharmacy personnel receive the report and fill the order as requested by the customer. Sergeant R.E. Zuch (personal communication, September 27, 2004), Non-Commissioned Officer in Charge of Pharmacy Supply, USAMH, states that the stockpiling which occurs with this manual method of ordering by its customers has resulted in the frequent expiration of pharmaceuticals. This is due to improper accountability of the expiration dates by the clinical personnel who stock their shelves, and excessive amounts of supplies that are not consumed based on their true demand. Aside from the financial loss that accompanies expired medications, there is an immense cause of concern in terms of patient safety because of the potential for the dispensing of expired medications to patients.

The final cause of concern in relation to supply management in the facility is that of lost patient charges. When medical-surgical supplies are consumed on a patient or pharmaceuticals are dispensed to a patient, these items incapable of being charged to the patient unless they are physically written down on the patient's chart. Pharmaceuticals given to the patient are recorded on the Physician Order (MEDCOM Form 688-R) and the patient's Medication Chart (MEDCOM Form 690-R) upon delivery of the medication by the nurse. Concurrently, supplies consumed on a patient are recorded on the patient's Progress Notes (SF 509), and durable medical equipment that is given to the patient is recorded on the Patient Release Discharge Instructions (MEDCOM Form 691-R). Therefore, if it is not documented in the patient's chart, true consumption of pharmaceuticals by the patient is unknown. This deficiency in medication management is a patient safety concern.

Similar to on the inpatient side, when the operating room performs a procedure on a patient, the chargeable supplies used are not linked to the patient, resulting in lost billable patient charges. Therefore, aside from billing for the specific procedure, itemized billing cannot be performed to charge the patient (or his insurer) for the supplies or pharmaceuticals consumed by the patient. These expenses not charged to the patient are known as lost charges. Lost charges are the result of an inefficient means of billing for supplies used on a patient. While the majority of our patients are covered beneficiaries, itemized billing charges can result in reimbursement from those patients who either have other health insurance, whose insurance would pay under third-party billing, or who are not beneficiaries and responsible for payment. With the proper interface from an automated supply tracking system, CHCS can employ its function of generating itemized bills for medical supplies. Truly, these lost charges subtract from the hospital's bottom line, and it would be of great benefit if HMEDDAC could capture these lost patient charges. Due to the current lack of analysis on the issue of patient charge recapture through itemized billing of medical supply consumption, it is not possible to give a realistic financial estimate of charge recapture at this time; however, because lost charges and patient charge recapture are important issues, they will be addressed in this analysis.

The supply chain management problems encountered by HMEDDAC necessitate a more efficient system. Specifically, an automated point-of-use (POU) supply system—where the vendor delivers supplies to the POU, and usage data is recorded at the POU—that employs just-in-time (JIT) inventory management. The point-of-use is the actual point of consumption and is the final point in the hospital supply chain. The just-in-time system is driven by final product demand: where each item is procured, manufactured, and delivered in the quantities needed just-in-time to satisfy demand in the next stage of the supply chain system or in the marketplace (Claycomb, Germain, & Droge, 1999). The hospital industry has embraced the concepts of continuous performance improvement practices with the belief that these concepts and programs will lead to an improvement in the quality, effectiveness, and efficiency with which health services are delivered (Klein, Motwani, & Cole, 1998). Just-in-time and performance improvements have integrating and overlapping practices, and the use of performance improvement practices improves JIT performance (Flynn, Sakakibara, & Schroeder, 1995). A JIT distribution system promotes the reduction of inventory and other forms of waste while maintaining (and possibly even improving) customer service because it identifies and suggests changing those circumstances that cause waste to exist. Besides JIT inventory management introducing cost savings, reduced inventories uncover previously hidden quality problems that may have lingered undiscovered in a traditional system—like HMEDDAC operates under—where buffer inventories conceal these problems (Claycomb et al., 1999). With continued success, JIT inventory systems have been introduced for materials management in hospitals (Duclos, Siha, & Lummus, 1995). Based on these supply chain inefficiencies and superfluous amounts of inventory, HMEDDAC must implement a JIT system of inventory as a means of promoting efficient use of its resources. The utilization of JIT at the POU creates demand history for the customer. Through implementation of par levels and the identification of reorder points, HMEDDAC will create a history of consistent demand with its distributor, USAMMCE. This consistency of ordering with USAMMCE will in turn create a concurrent demand history with its prime vendor, allowing the entire chain to function in a JIT environment. Consequently, JIT must start at HMEDDAC's level.

Besides the hospital's need to reduce inventory through a system like JIT, it should employ supply automation equipment and processes to eliminate the majority of the inefficiencies found in HMEDDAC's current supply chain management. Electronic data interchange (EDI) has made progress in automating these processes in the healthcare supply chain ("Healthcare Supply," 2002). Electronic data interchange refers to a technology used to exchange information and data across organizations (Germain & Droge, 1994). These automated systems are necessary to create demand history and give accurate consumption data. Similarly, the automation would support JIT implementation that would decrease inventory and improve internal control and forecasting of supply expenditures. Point-of-use consumption information is required for accurate patient charging, and this consumption data is required to drive patient charges and accurate activity-based costing information ("Healthcare Supply," 2002). Materials management systems can facilitate routine daily processes through POU systems that would eliminate replenishments based on hand counts and provide meaningful usage and cost data (Davis, 2004). Currently, one reason such high levels of inventory have been seen at HMEDDAC is the result of customers establishing par levels for their supplies without supporting usage data. This lack of usage data results in an unawareness of verifiable need (Rosen & Veral, 2002). Still, some customers have not even attempted to establish par levels. Accordingly, the usage data an automated system provides would be used to establish, monitor, and adjust supply par levels, which should be a three to five day supply of frequently used items (A.J. Lopiccolo, personal communication, October 5, 2004).

The discovery of the multiple inefficiencies in HMEDDAC's supply chain management clearly establishes the need for more advanced supply automation in combination with JIT inventory management. For this reason, Major Lopiccolo utilized the Shewhart Cycle for performance improvement and formed a process action team. The team's purpose was to improve the supply process in the facility to more effectively provide the right supply, at the right time, in the right amounts. Thus, Major Lopiccolo and the process action team recommended HMEDDAC purchase automated point-of-use equipment from Omnicell Inc. Their expectation is that this project will increase the efficiency of operations, improve quality, increase customer satisfaction, improve material flow, decrease lead-times, decrease inventory, allow itemized billing and track patient consumption, and streamline supply operations. Although a business case analysis had not yet been performed, a surplus in 2003 fiscal year-end money became available; and a military interdepartmental purchase request (MIPR) was submitted on September 24, 2003, in the amount of $915,609.72 to the U.S. General Services Administration (GSA) for the purchase of the Omnicell equipment. This amount was based on original estimates obtained from Omnicell for the requirements provided by HMEDDAC. The Omnicell implementation, which included installing, configuring, and activating the *OmniSupplier* (the technical name for the Omnicell cabinet) cabinets, was conducted in three phases. Phase I included the installation of Omnicell cabinets for the OR, anesthesia, and the post-acute care unit (PACU). These areas began full implementation of Omnicell in May, 2004. Phase II included the ER, family practice, and the medical-surgical unit (MSU), our inpatient ward. Additionally, pharmacy cabinets were installed and implemented in the ER, MSU, anesthesia, family practice, and PACU. Complete implementation of Phase II areas occurred on June 29, 2004. Lastly, Phase III implementation was scheduled to begin on October 25, 2004, and was completed mid-December. This phase included the installation of Omnicell cabinets in the mother-baby unit (MBU), general surgery, same day surgery, and orthopaedics. Additionally, pharmacy cabinets were installed in same day surgery, general surgery, and the MBU. Final startup costs, which include installation, equipment, and one year's salary for the Omnicell contract administrator, were estimated at $806,918. The remaining MIPR funds were spent on Pharmacy equipment that does not relate to Omnicell. Table 1 displays the startup costs for complete implementation of Omnicell.

Table 1

Startup Costs for Omnicell Implementation

Total Startup Costs for Complete Implementation of Omnicell:	
GSA Contract Fee:	$34,399
GSA Overhead:	$21,290
Omnicell Equipment	$641,759
Shipping	$25,470
Contract Services (Omnicell Administrator annual salary)	$84,000
Total Startup Cost	**$806,918**

*Maintenance included for 19 months after final implementation, expected in November ($26,616 annually after that)

Statement of the Question

The ineffectiveness of HMEDDAC's traditional supply chain management system has resulted in supply inefficiencies and waste throughout the entire distribution chain. Supply automation and JIT would be advantageous for HMEDDAC and provide much needed improvements to its management of supplies; however, timing and the last-minute availability of year-end excess funds did not allow the costs and benefits of this capital investment to be examined prior to purchase. While the decision to purchase the Omnicell equipment was in no way an irrational one, the purchase lacked sufficient analysis to make a firm decision that the benefits, both quantitative and qualitative, outweighed the financial costs, time, and efforts associated with procurement and implementation of the project. Neither a capital investment analysis, nor a business case analysis (BCA) was performed prior to purchasing the Omnicell equipment. With total startup costs, following the three-phased implementation (completed in December, 2004), amounting to over $800,000, two questions must be asked, "Was purchasing Omnicell worth the financial investment?" and "Does Omnicell add sufficient value for HMEDDAC to justify expanding the program?" An analysis must be performed to determine whether the quantitative and qualitative benefits of Omnicell implementation at HMEDDAC provide adequate return on investment (ROI) and effectively substantiate expanding the program.

Literature Review

In reviewing the literature regarding logistics and materials management, the pertinent supply chain management issues revolve around just-in-time manufacturing and inventory management, point-of-use distribution, and supply automation. These articles describe the uses and benefits of implementing these systems. While just-in-time was originally a manufacturing concept, its utilization in the production and delivery of health care cannot be overlooked. From a functional perspective, medical care can be viewed as an input in the production function for health. Alternatively, the process may be viewed as one where various inputs are combined to produce medical care as a final product (Henderson, 2004). Regardless of which view one holds, medical logistics and efficient management and utilization of these resources plays a critical role in the production of health. Thus, similar to manufacturing, effective logistics management systems must be employed in our health care facilities in order to achieve successful outcomes.

Supply chain management.

A supply chain is a network of facilities that performs the functions of procurement of material, transformation of material to intermediate and finished products, and distribution of finished products to consumers (Billington & Lee, 1992). Supply chain management (SCM) is concerned with the management of these activities such that the product passes through the chain in the shortest time with the lowest cost (Tan, Shaw, & Fulkerson, 2000). Supply chain management emphasizes total integration of all the business entities within the supply chain. Thus, manufacturers and merchants applied the concept to improve product development, quality and delivery goals, and eliminate waste. Supplier strengths are utilized to seamlessly integrate logistics functions with transportation partners to deliver directly to the point-of-use (Lyman, Tan, & Wisner, 2002). To balance customers' demands with the need for profitable growth, many firms have moved aggressively to improve SCM (Chandra & Kumar, 2000). Supply chain management has two goals: the coordination of each tier in the process, and matching supply with the market demand (Tan et al., 2000). Instead of saturating warehouses with inventory, this philosophy integrates internal and external activities. The goal is to replace inventory with information to provide visibility so that goods can be replenished quickly and arrive at the points-of-use in smaller amounts in a JIT system. Therefore, short and reliable order cycles, and the ability to fill entire orders are critical customer service elements in this system (Lyman et al., 2002). Undeniably, information sharing is a key ingredient in coordination of the supply chain. Just-in-time and continuous replenishment programs rely on effective information sharing to improve coordination between the supply chain processes to enable the material flow and reduce inventory costs. Poor information sharing is a common root cause for supply-chain related problems (Tan et al., 2000).

Different sources of uncertainty exist along a supply chain. Inventories are often used to protect the chain from these uncertainties. A challenge for logistics managers is how to control inventories and costs along the chain while maximizing customer service performance (Billington & Lee, 1992). Control of these functions can be centralized or decentralized. With centralized control, production decisions are made centrally based on material and demand status of the entire system. With decentralized control, each individual unit in the supply chain makes decisions based on local information (Billington & Lee, 1992). Inventory investment and service performance are key measures of which system works better.

Supply chain management concepts should also be employed in the purchasing function of an organization. Since purchasing accounts for a large percentage of total operating costs, purchasing becomes an important strategic function (Rosenblatt, Herer, & Hefter, 1998). Thus, the acquisition policy decision of choosing between economic order quantity (EOQ) and JIT must be well thought out. Traditional inventory management practices centered around the EOQ model, which focuses on minimizing inventory costs rather than on minimizing inventory. In the EOQ model, a manufacturer places several orders to its suppliers every year. The size of each order is enough to satisfy the production demand for a certain period of time (Fazel, 1997). However, correct usage of the EOQ model should result in lot sizes that closely approximate JIT lot sizes. The most regularly consumed items that can be forecasted most accurately are best suited for the EOQ model. While it might be difficult to identify and measure costs of not maintaining inventories under JIT, inventory carrying costs of the EOQ system should be identified and estimated, if possible. Carrying costs consist of the cost of physical storage, opportunity cost of the working capital tied up in purchased goods, taxes and insurance paid on inventory items, and inventory spoilage and obsolescence (Fazel, 1997). So, if a company chooses not to employ the traditional approach, it can reap the benefits of a well implemented JIT system which results in improved quality, lower manufacturing costs, lower ordering costs, elimination of waste, streamlining of the production process, and the elimination of production and supply bottlenecks (Waters-Fuller, 1995).

Just-in-time.

The positive impacts of JIT on the operational and strategic facets of organizations in the private sector are well documented (Yasin et al., 2004). Just-in-time is a management philosophy of problem solving. It was pioneered and made successful by the Japanese with Toyota's implementation of JIT manufacturing in the 1970s. Just-in-time's integrated approach is aimed at improving quality and facilitating timeliness in supply, production and distribution (Claycomb et al., 1999). With JIT, supplies and components are pulled through a system when and where they are needed, helping to drive out waste (Aghazadeh, 2004). While the fundamental objective of JIT is to eliminate all waste from the entire supply chain (Claycomb et al., 1999), a fundamental purpose of this strategy is to cut costs and use employees as efficiently as possible. Inventory and time are not exceeded in a JIT system. So any costs related with unnecessary inventory are done away with, resulting in throughput improvements (Aghazadeh, 2004). The JIT system is driven by final product demand: where each item is procured, manufactured, and delivered in the quantities needed just-in-time to satisfy demand in the next stage of supply chain system or in the marketplace (Claycomb et al., 1999). Just-in-time seeks to make quality better and provide on time production and shipment of products. When these goals are met, it results in decreased inventory and costs and improved firm performance. Consequently, companies who have successfully implemented JIT have substantially cut lead times, drastically reduced raw material and finished good inventories, and effectively increased asset turnover (Aghazadeh, 2004).

A common theme in the literature is the connection between electronic data interchange (EDI) technology and JIT strategy. The connection between the two is the result of their focus on small lot production or order sizes. Electronic data interchange refers to a technology used to exchange information and data across organizations (Germain & Droge, 1994). Electronic data interchange affects the entire distribution chain by affecting information speed and fostering integration and alliances. Firms initiating EDI with suppliers have reduced lead time length and uncertainty, order and data storage costs, inventory levels, and order errors, while those instituting EDI with customers have noted the same, along with increased customer satisfaction and market share (Kekre, Mukhopadhyay, & Kalathur, 1995). Both JIT and EDI are symbolic of the following: long-term relational exchanges, exchanges characterized by trust, shared costs and rewards, and substantial planning and performance measurement (Germain & Droge, 1994).

Ideally, JIT integrates the entire supply chain's marketing, distribution, customer service, purchasing, and production functions into one controlled process, resulting in improved coordination between a manufacturer and its supply and distribution networks. This is a pull system, meaning demand originates from the final customer and ripples up the supply chain. Just-in-time requires production and delivery of a specific product in the exact quantity needed at the precise time required, conforming to quality specifications every time, all the while minimizing total supply chain cost by eliminating waste from the delivery and production systems of supply chain members (Claycomb et al., 1999). This is done within narrow time windows with minimum materials handling, relying on the ability of suppliers to consistently deliver appropriate quantities within a fixed time frame (Aghazadeh, 2004). This process is difficult to achieve and depends on integrated communication with a strong emphasis on implementing continuous quality improvements with the goal of zero defects and no variances (Claycomb et al., 1999).

Just-in-time's reduction in inventory carrying costs gives rise to smaller shipment sizes and increases in shipment frequency. This can result in higher transportation costs. Under these circumstances, a possible solution to mitigate these costs is consolidation (Bagchi, n.d.). An effective consolidation program could benefit a small organization like HMEDDAC in its implementation of JIT. With the basic aim of JIT being to purchase, transport, and produce the required items just-in-time for their production or when they are needed, vendors are required to increase the frequency of deliveries and reduce the size of shipments. Thus, the consolidation of inbound materials may help in lowering rates while at the same time reducing order processing and handling costs (Bagchi, n.d.). This is possible in HMEDDAC since several clinics may order the same line item. Bagchi (n.d.) concludes that the advantage of consolidation lies in lower transportation costs and lower inventory costs at the destination, and the disadvantage comes from the inventory and material handling costs and overhead costs at the consolidation center. As an extension of consolidation, Jarrett (1998) presents the case for centralization of warehousing and central inventory control rather than allowing each department deal with suppliers individually. He further illustrates how the full-life potential of goods can be better assured by central warehousing and the reductions in costs that consolidation would bring.

Logisticians must make strategic level decisions in order to manage uncertainty, customer service and cost. Some of these decisions include the following: make to order vs. make to stock, push (moving products based on planning and forecasting) vs. pull (moving products based on demand) inventory deployment logic, and inventory centralization vs. decentralization (Wanke & Zinn, 2004). One of their most important management functions is that of inventory control, which includes forecasting, determining requirements and setting targets, and controlling stock throughout the supply chain. This goes hand-in-hand with their supervisory function of monitoring stocks in the warehouse (Ballard, 1996). With JIT, efficient management of stocks is essential. The two types of stock logisticians are most concerned managing with is the cycle stock and safety stock. Cycle stocks arise when shipments occur in lots rather than in a continuous supply. This stock usually equals one-half of the replenishment quantity (Hax, Majluf, & Pendrock, 1990). Fixed re-order points (ROP) are traditionally used to maintain this type of stock; however, using this system can be an undesirable restriction if you experience variable demand and lead times (Silver, 1991). Variable demand is synonymous with seasonal demand in healthcare. This type of demand is representative of health care in the hospital setting. A JIT environment works to minimize this predicament as much as possible through continuous replenishment. This pull system uses a finite base stock level (also known as buffer or par level) that triggers inventory replenishment as each unit is withdrawn (Kirkavak & Dincer, 1996).

The usage of safety stock protects against uncertainty in demand over the lead time. Given the various degrees of uncertainty in supply and demand that impact their stock-keeping units, material managers have a difficult time determining how much safety stock to hold and when to initiate orders (Billingham & Lee, 1993). Sometimes this safety stock comes in the form of unofficial inventory—products already distributed to various departments and not yet used. For example, these items may get stashed away by the clinic staff for fear of an unlikely stockout that may never come to fruition (Lefever, 1999). The literature demonstrates that lack of an integrated system, like JIT, coupled with unduly liberal lead times, can lead to excessive permanent safety stock (Strassman, 1992). To achieve the cost-savings offered by JIT minimal inventories, supplier reliability is paramount since supplies must arrive when they are needed. Therefore, the JIT system must be designed to assure on-time delivery of products as needed, so as to minimize safety stock levels and allow the vendor to hold the cost of inventory (Deakin, 1988).

Services are much like manufacturing in that they both utilize processes that add value to the basic inputs used to create the end product. Since JIT focuses on the process instead of the product, it can be applied to any group of processes, like healthcare. Just-in-time seeks ways to make processes more efficient through gradual and continuous improvements to produce a good or service without waste. This is accomplished with the constant and continual testing of processes (Canel, Rosen, & Anderson, 2000). Canel et al. lists the following main themes of JIT as applicable to service industries: total visibility, synchronization and balance, respect for people, flexibility, continuous improvement, simplicity, and a holistic approach. They further state that training of employees, investment in technology, improvements in quality, and an emphasis on standardization are activities that can improve performance in services with JIT. Jarrett (1998) affirms that JIT concepts can be applied in a service environment, and examines the part it can play in U.S. hospitals. Good candidates for JIT are those operations that are repetitive, have high volume, and deal with tangible items. Since these characteristics are representative of the typical hospital, JIT would benefit hospitals. Jarrett further asserts that establishing the right relationships with materials and pharmaceutical suppliers means deliveries can be made on a JIT basis (Jarrett, 1998).

Duclose et al. (1995) also list the same JIT concepts as Canel et al. (2000), as being applicable to service organizations. From a non-manufacturing perspective, inventory and purchasing are the most obvious areas for implementing JIT techniques, which translate into frequent releases and deliveries with few suppliers (Duclose et al., 1995). Under JIT continuous improvement in warehousing operations, Duclose et al. state that companies strive to reduce errors and complaints, decrease storage space, increase the frequency of replenishment, increase employee involvement, and encourage team identity and teamwork. Subsequent to their efforts, these companies achieved higher productivity and increased customer service.

Just-in-time in health care.

The majority of current supply chain research has been focused on JIT systems in the manufacturing industry. Consequently, little research has been directed at JIT implementation in health care; rather the research has been directed at process and information system improvements (Jarrett, 1998). Jarrett states that the increase in health care costs and inefficiencies are due to inadequate and tedious purchasing procedures. While the health care industry has been trying to manage its escalating costs and improve its supply chain management, it has been reluctant to take advantage of the savings associated with the adoption of manufacturing's JIT system. There has been a lack of published research focused on determining the return on investment from JIT implementation in health care. Most government-supported research has been exclusively in the areas of price control efforts and medical treatment restrictions rather than evaluating and recommending operational efficiency improvements (Jarrett, 1998). Executives from Baxter HealthCare argue that process redesign in the health market has been too focused on internal operations, excluding wider business network redesign in order to achieve strategic advantage. Baxter's analytic systems' automatic purchasing features reconfigure the business relationship with hospitals so that the provider becomes a value-added partner. Jarrett describes how Baxter's ValueLink program provides integrated information management that delivers products on a JIT basis in a ready-to-use package to the health care provider.

So, for logistics to employ a successful JIT system, it must have an efficient production and distribution process.

Service environments, as in health care, are good candidates for JIT in settings where operations are repetitive, have reasonably high volume, and deal with tangible items; however, these services must be "manufacturing-like" in nature. Whitson (1997) gives specific examples of where JIT can be applied in health care. Internal expenses such as stockroom and central supply can benefit from resource reduction with JIT implementation. Central supply's role is diminished in a JIT environment because of a decreased need for storing goods between supplier delivery and internal delivery to units. A true JIT hospital, however, would receive items from a supplier already packaged to go straight to the appropriate unit (Whitson, 1997). Next, materials management and pharmacy contain the most observable opportunities for applying JIT principles to health care (which was the focus for HMEDDAC's implementation of Omnicell). Relationships with suppliers focus on three areas: reducing the number of suppliers, using suppliers that are geographically closer to the recipient, and improving relationships with suppliers. Whitson points out that suppliers are chosen so inventory levels can remain low, eliminating the need for large safety stock. Within the JIT environment, reducing total product cost is a fundamental goal (Whitson, 1997). As hospitals reduce their allocations and identify their true costs and the basis for these costs, they position themselves to adopt activity-based costing. Thus, Whitson demonstrates that JIT concepts have the potential to significantly improve hospital operations. By increasing value-added activities, hospitals can improve service to their patients and provide better operating margins for their institutions.

Jarrett (1998) states that most of the knowledge that has resulted from JIT research conducted in the manufacturing and distribution industries would also be relevant to the health care industry. He maintains that the health care logistical community has not recognized the similarity and made the comparison between the manufacturing of products and the provision of care to patients. One example of health care supply chain inefficiency comes as a result of health care practitioners experiencing a breakdown in distribution. Subsequently, their preparation for one of these untimely breakdowns is to stockpile supplies. Providers state that this practice exists because of the liability incurred by a patient dying because critical supplies were not available (Jarrett, 1998). According to Jarrett, this fear or practice has hindered the health care industry's efforts at effective supply chain management. In addition to poor inventory control, health care's supply chain management problems include years of outdated supply-chain strategies and failure to adopt uniform electronic standards. Using the retail grocery industry as an example, Loudin (1997) believes that an inventory control solution is one that scans products out of inventory and automatically orders replenishment stock as they are used in patient care at the point-of-use. Just-in-time in health care would attempt to have the right product in the right place at the right time in the most cost effective manner to serve efficiently the health care needs of the end consumer (Jarrett, 1998).

Beaulieu et al. (2002) cited the benefits of a point-of-use replenishment and distribution systems within the hospital setting. This point-of-use, or stockless, materials management distribution consists of deploying logistics personnel delivering supplies to the patient care units, and ultimately the point of care. This creates an external and internal supply chain. This method requires the continuous flow of information between the point-of-use and the supplier in order to obtain visibility of demand. This information flow functions to coordinate replenishment and user needs (Beaulieu et al., 2002). With this method the two hospitals Beaulieu et al. studied reduced their on-hand inventories by over 70%. Additionally, the hospitals benefited from staff reduction, in the form of reduced workload for both the materials management department and patient care staff needed for point-of-use replenishment following the adoption of stockless distribution. Accordingly, savings of this type result in recurrent savings for the organization. A final benefit of the stockless method versus conventional replenishment was gained in the higher level of service it provided, which translated into fewer product shortages in the patient care units. Beaulieu et al.'s findings reveal that in addition to savings linked to patient care unit replenishment, savings related to internal unit logistics may also have a significant impact, both financial and in terms of healthcare quality.

Automated point-of-use in healthcare.

Automated point-of-use (APU) systems can improve productivity. Valestin (2001) demonstrated the value of an APU system in facilitating efficiency and productivity in patient care, billing, medical records, physician relations and security, as well as in materials management. He concluded that the key to the success of this cost-effective system has been from the creative use of data collected during APU transactions. As Valestin points out, a traditional manual system has definite drawbacks. Counting and maintaining par levels of supplies requires manpower, and multiple users and open shelving contributes to chronic unpredictability of supply inventory. The easy access to supplies is a potential security problem. Additionally, patient billing systems for supply charges require compliance by users whose focus is patient care, not materials management. The APU system is a closed shelving system that includes custom-designed visible compartments for unit supplies. Access is through a keypad and display screen on the shelving unit. The operator enters their username and password, as well as the patient's name and requested supply item. Then, the shelf door unlocks long enough to retrieve the item. Valestin states that, "With this simple transaction, the clinician has retrieved a supply item, quickly and easily. The APU system and database, however, have performed nothing less than a materials management miracle" (p. 26). The minute amount of information entered by the clinician is what will make traditional stocking systems obsolete.

Automated supply systems are helping facilities better manage inventory, track and reduce costs, recapture lost charges, improve efficiency, and enhance patient care ("Improving Inventory," n.d.). Valestin (2001) illustrates the numerous functions that the hospital can utilize with this system. First, the APU automatically debits a patient for the cost of a billable supply item. This occurs by the immediate, automated posting of the cost of an item to the proper expense account. The APU interfaces with a patient's medical records to report consumption of supplies or pharmaceuticals in real time. The APU also allows warehouse personnel to evaluate supply levels and generate a pick list for replenishment electronically from a remote location. Since the APU user must "log in" for each transaction, additional tracking is provided by the APU. For example, the APU can expose unusual use levels and record physician usage patterns, as well as identify training needs and security violations in the system. Valestin also describes how the APU system is programmable and can be tailored specifically for the unit or even individual employees. The APU's organization and efficiency also benefits patient care delivery. A greater selection of supplies and pharmaceuticals are available closer to the point of care, which increases provider efficiency and minimizes patient risk. Additionally, Valestin's (2001) APU study achieved a decrease in the average supply cost per procedure as well as a substantial cost savings well beyond original projections. Clearly, Valestin's APU implementation study demonstrates improved efficiency and productivity in patient care, billing, medical records, physician relations, security, and materials management, as well as cost-effectiveness, as a result of the APU.

Automated supply management systems have been introduced to help institutions better manage their inventory and recognize revenues otherwise lost to internal efficiencies ("Revamping Supply," n.d.). Nathan and Trinkaus (1996) researched JIT concepts to health care inventories and found positive results. With most medical facilities spending about 35% of their budgets on supplies and the labor to manage them, poor inventory practices can needlessly increase costs while diminishing patient care. Therefore, according to Nathan Trinkhaus, the importance of reducing inventory costs is relevant in today's health care management. The authors state that many hospitals have gone from a system of central stores servicing the inventory of the point-of-use locations by placing orders with and receiving orders from outside suppliers to JIT stockless systems contracts where the supplier acts as a central store and delivers directly to the point-of-use location. A product that performs a stockless, JIT supply distribution service that utilizes integrated information management for managing the supply replenishment process within hospitals is Baxter's ValueLink. This system ensures that the supply chain is managed to its maximum efficiency by delivering required supplies, in the hospital's desired unit of measure, to predetermined points-of-use on a timely basis. This total quality management system (TQM) uses proven JIT and electronic data interchange (EDI) concepts (Nathan & Trinkhaus, 1996). Their case study on two hospitals using this system realized the following benefits: a streamed supply replenishment process, elimination of general stores and central supply inventory, space savings from inventory reduction, revenue-generating opportunities from vacated space, labor savings in the supply replenishment process, purchases and accounts payable efficiencies through advanced system interfaces, product standardization opportunities, and elimination of packaging waste. As these hospital cases point out, the proved concepts of JIT and EDI can indeed work in the health care industry (Nathan & Trinkhaus, 1996).

Besides utilizing APU equipment for improving SCM, pharmacy automation can save hospitals money and improve patient outcomes through a reduction in potential medication errors. The Institute of Medicine (IOM) (1999) estimates that between

44,000 and 98,000 Americans die in hospitals each year as a result of medical errors that could have been prevented, and the increased hospital costs alone from preventable adverse drug events affecting inpatients are over $2 billion nationwide. Further, the IOM states that many medical errors could be avoided if clinical data were more accessible and readable and if prescriptions were entered into automated order entry systems that could check for errors and oversights in drug selection and dosing. To facilitate a reduction in medication errors, today's automated medication management technology incorporates a variety of features that are specifically designed to help healthcare facilities reduce medication errors and improve efficiency ("Reducing Medication Errors," n.d.).

The fast-growing business of manufacturing and installing automated supply and pharmaceutical cost management systems has been advantageous to hospital users and to the companies themselves. In the case of pharmaceuticals, automated POU systems improve efficiency, allow expansion of floor stock medications, and simplify the management of controlled substances ("Clinical and Financial Benefits," n.d.). The key to these systems is the computer technology that enables providers to track supply and drug utilization, increase security, produce medication doses for patients, and even communicate with their medical-surgical distributors or drug wholesalers. These supply and drug management systems enhance productivity and do it cost-efficiently. Additionally, the data these systems produce can help a distributor supply a hospital faster and more efficiently. These systems assist distributors by promoting the prime vendor concept and the use of stockless and JIT distribution programs. The EDI communications between these two parties provide mutual benefits (Werner, 1995). Besides Baxter Healthcare, the corporations whose automated products dominate the market are Pyxis, Omnicell Technologies and ParExcellence Systems. Examples of the benefits from these products will be discussed to demonstrate consistent findings in the literature.

One year after installation, the point-of-use, controlled-access inventory control equipment designed by ParExcellence Systems saved $760,000 for a Louisiana medical center. These savings came from the recovery of lost patient charges, the decline of stockpiling and stored departmental inventory, and the reduction of materials management staff since installation (Anonymous, 2003). The equipment automates the tracking of patient charges and the replenishment process, and provides cost accounting information through the computer-controlled dispensing units. The product also utilizes EDI by collecting supply information at the point-of-use and sending it to vendors, distributors and the hospital's material management system (Anonymous, 2003).

The POU inventory control product manufactured by Pyxis Corp. produces similar results. Barlow (1992) describes how San Jose Medical Center is saving money by reducing inventory and capturing lost patient charges. Pyxis has also improved the hospital's productivity because materials management uses the computer to track inventory, eliminating the need for hand-held bar coders. The hospital's director of materials management states, "We know who is using what, where and when on demand, so we can reduce the amount of inventory at those locations" (Barlow, 1992, p.14). The results of the data have resulted in a 50% reduction in the value of inventory for its nursing supply carts. Pyxis is also being used in the operating room to map trends of supply usage to determine supply costs per procedure and identify what products will be needed, when they will be needed, and for which procedure (Barlow, 1992). Another hospital with similar results had implemented Pyxis in three departments of its facility. Six months after implementing the automated inventory control, overall issuing to these areas had decreased by 28.7%. Subsequently, the program was expanded throughout the hospital to reduce inventory issuing and increase net savings throughout the facility (Friedman, 1994).

Similar to the other products, Omnicell typically interfaces with hospital operating systems, like billing and inventory systems, and with clinical systems for Diagnostic Related Groupings information. With Omnicell, a hospital has the ability of an inventory interface for a JIT environment that transmits par level data to the hospital's inventory system on an automated request basis from the customer's inventory system. The result is an automatically generated purchase order sent electronically to the distribution vendor. The company's study of 11 hospitals using its product showed a median drop of 22% in consumption, 33% in inventory, 92% in lost charges, and a potential reduction of one FTE in restocking per 100 beds (Werner, 1995). Interestingly, Omnicell's tools can integrate with legacy systems to further streamline order processes and make logistics management more efficient (Anonymous, 2003). Hofer (2001) cites a case of Omnicell's success in a hospital setting. After the first three months of using Omnicell, this hospital experienced a 25% reduction in supply costs in the emergency department along with an increase in the number of patient charges captured. Additionally, the operating room produced a 50% reduction in the consumption of sutures.

With Omnicell, savings occur because no charges are lost, since each item taken from the cabinet is immediately accounted for with no need for separate billing or charting. If each item removed is recorded, there are no lost or uncaptured charges (Hofer, 2001). Increased supply accountability occurs with Omnicell because the user gains access only by entering his username and password. Then, the user highlights a name on the cabinet screen and presses a button on the bin shelf that causes the system to charge the patient for an item from that bin. Pressing the button also triggers a message to the materials management system to add that item to the restocking list. With this system, Omnicell can generate reports that track supply usage by diagnosis or procedure code, for future use in developing managed care pricing and best practice protocols. Thus, hospitals can accurately track supply use by patient to identify, "the true cost per patient" ("When there's too much control," 1998).

Purpose

Omnicell equipment provides HMEDDAC with a complete and flexible process for the management of supplies, effectively placing the management of supplies back into the logisticians' hands. Thus, HMEDDAC will use Omnicell to make JIT, along with its performance improvement principles, a reality. Omnicell's automated POU supply replenishment equipment was purchased to realize maximum benefits from the enhanced capabilities it will provide HMEDDAC. With the implementation of Omnicell, the hospital anticipates the realization of the following goals: improve usage data capture; reduce supply consumption and inventory; increase accountability for product utilization through ID entry and the security added from computerized locking cabinets; employ Omnicell's expiration date tracking and med-profiling functions to increase the safety of pharmaceutical dispensing; improve inventory and information management; increase overall efficiency and productivity for both materials management and the customers;

realize savings in supply costs; create an orderly, organized, seamless supply replenishment process; effectively record supply usage by patient with improved patient charge capture and interface with the billing system; and enhance patient safety and staff satisfaction by having the right product in the right place at the right time in the most cost-effective manner.

The purpose of this paper will be to determine whether purchasing Omnicell for the hospital was a good investment and substantiate whether the program should be expanded further within HMEDDAC. By conducting an analysis of the quantitative and qualitative benefits Omnicell provides HMEDDAC, a determination can be made as to whether Omnicell is providing HMEDDAC with an adequate ROI. A financial outcomes analysis will be combined with a qualitative evaluation of operational efficiencies achieved as a result of Omnicell implementation. Because a capital investment analysis was not performed prior to purchasing Omnicell, this analysis will serve two purposes. First, it will serve as a retrospective analysis to determine if Omnicell was worth the investment. Second, the analysis will assist HMEDDAC's executive board with its decision on whether to expand the program.

Methods and Procedures

Financial performance of Omnicell implementation is first and foremost in this analysis. The first financial outcome that will be examined is the dollar value of the excess inventory that each customer turned in to the medical warehouse prior to its implementation of Omnicell. This turn-in reduced customer inventory levels to the initial par levels of stocked items in the Omnicell. Therefore, the inventory reduction was a one-time cost avoidance that resulted from Omnicell implementation. The reason this is quantified as a savings from Omnicell implementation is because after this inventory was turned in to the medical warehouse, the inventory was used to replenish par levels within the Omnicell based on actual usage. Additionally, the values for the inventory on the date of activation for each customer will be quantified because the customer used their previously purchased and retained inventory for initial Omnicell par levels, resulting in cost avoidances for HMEDDAC during the implementation phases. These turned-in and retained values will, in effect, quantify the amount of overstock maintained by each customer prior to Omnicell implementation.

Next, the cost savings in supply expenses per customer will be identified. Historical data will be used as the baseline for each customer. Specifically, this historical baseline of comparison will comprise total monthly expenditures for medical-surgical supplies for each of the twelve months prior to Omnicell implementation for that customer. Then, the monthly expenditure data, now based on point-of-use actual consumption, for each month following Omnicell implementation will be measured against those previous expenditures, comparing each month to the corresponding calendar month from the previous fiscal year. Comparing the same calendar months from before and after Omnicell implementation accounts for seasonal variations and assumes no change in mission or staffing levels and a similar case mix. Data collection will cease with expenditures through January 31, 2005. However, a limitation to this approach is Omnicell's phased implementation schedule which will result in only two months of data or less for some Phase III customers and will not yield at least 12 months of post-implementation data for any customer. This will decrease the reliability of any type of forecast. Table 2 presents the data collection period for each customer's post-Omnicell implementation supply expenses.

Table 2

Supply expense data collection time frames for post-Omnicell implementation

Phase I	***Phase II***	***Phase III***
1 May 04 - 31 Jan 05 OR Anesthesia	**1 Jul 04 - 31 Jan 05** ER Family Practice **1 Aug 04 – 31 Jan 05** Med-Surg Unit	**1 Nov 04 – 31 Jan 05** OB/GYN **1 Dec 04 – 31 Jan 05** General Surgery Same Day Surgery Orthopaedics **1 Jan 05 – 31 Jan 05** Mother-Baby Unit

Lastly, cost savings attributed to Omnicell will be based on projections of cost savings to be realized plus increased reimbursements through additional revenues earned with more effective patient billing. Currently, CHCS has a limited capability for itemized billing of billable patient supplies, and Omnicell has the EDI interfacing capability to provide CHCS with timely and accurate individual patient supply usage information. Although Omnicell has the ability to track patient-specific supply usage, recapturing of lost charges cannot occur until HMEDDAC employs Omnicell's interfacing capabilities with CHCS' billing system. While the majority of patients at HMEDDAC are beneficiaries who are not billed for their procedures, HMEDDAC can capture itemized charges on those patients with other health insurance, through third-party billing, as well as those pay patients, who are not beneficiaries and are responsible to pay for care received. The method for this analysis will be to generate a *case supply list* or *case kit*, reproduced from standardized *surgical preference cards*, for each of five specific types of OR procedures. A case supply list is a standardized list of equipment and supplies—maintained in the OR—used for a specific procedure to ensure consistency among like procedures. Each case supply list contains an itemized listing of the supplies used to perform the procedure, along with the cost associated with each item. These lists will be used to generate an itemized bill for those cases based on the associated charges for those supplies. The key to this analysis is to determine the increase in revenue resulting from itemized billing of medical supplies compared to the pre-Omnicell process of charging by procedure. Based on the average monthly workload for these cases, forecasted projections will be determined for future cost savings and revenues available through the recapturing of charges made possible with Omnicell. These projections will be used solely to demonstrate the capabilities of Omnicell in capturing and tracking costs for the hospital.

Financial results alone should not be used to measure the performance of an improvement effort. Using financial performance alone as the indicator for success could mislead the organization as to how successful the JIT effort and POU system are (Ahmed, Mehra, & Pletcher, 2004). Implementing JIT inventory management and automated POU supply replenishment can enhance several variables of non-financial performance. From a qualitative standpoint, the potential benefits for HMEDDAC from Omnicell are numerous. This paper will identify and describe specific examples of these qualitative benefits. The benefits Omnicell brings to variables like customer satisfaction, patient safety, supplier reliability, staff accountability, security of supplies, best practices, consumption tracking capabilities, reporting and analysis capabilities, and time savings will be qualitatively explored to discuss how benefits in these areas enhance organizational effectiveness and ultimately improve patient care. Along with financial outcomes, these qualitative outcomes will be used to validate the purchasing of Omnicell and substantiate whether HMEDDAC should expand Omnicell's application within the hospital.

The financial analysis should demonstrate reliable and valid results. Reliability looks at consistency, replicability, and duplication of results. In this analysis, the key question is whether the results were consistent. If a similar trend is seen for the consecutive months included in this analysis, then the analysis demonstrates consistency of outcomes. If this analysis demonstrates similar financial outcomes as other similar case studies in the literature, it shows that these results can be replicated using these analysis techniques. The inability to compare at least one year of post-Omnicell implementation to one year of pre-Omnicell implementation may limit the reliability of the results. The partial implementation within the hospital and different time frames for implementation make it somewhat difficult to have consistency between all the customers within HMEDDAC, and it makes it difficult to compare the return on investment with other facilities that have done full implementation of Omnicell. However, reliability of results is increased due to all of the customers who have implemented Omnicell receiving the same type of analysis. Validity looks at whether the analysis is measuring what it is supposed to be measuring. Some of the problems with validity might occur in the realm of the forecasting. Based on the limited data from post-implementation of Omnicell, the analysis might be insufficient for a very accurate forecast and may result in an overly optimistic forecast. However, since Omnicell will have been implemented in the majority of the hospital by the end of the analysis, the sample is large enough to be representative of the expected cost savings with expansion of the program. Additionally, because there is no historical data on patient supply itemized billing prior to Omnicell, this will cause some accuracy issues with regard to the inferences drawn from the forecasted patient charge recapture estimates. The limitations encountered in the analysis will be described in detail within the *Discussion* section of this study.

Results

The financial analysis which compares the total monthly expenditures prior to Omnicell implementation with post-Omnicell implementation—to demonstrate cost savings resulting from Omnicell's implementation—is displayed in Table 3.

Table 3

Monthly expense comparison analysis between prior and post-Omnicell implementation

Monthly Expenditures Prior to Omnicell Implementation				Monthly Expenditures Post-Omnicell Implementation				Lower than Workload % is Good	Positive % Change is Good	Negative % Change is Good
Anesthesia	Monthly Total	Workload	Cost per Procedure	Anesthesia	Monthly Total	Workload	Cost per Procedure	Total % Change in Expense	% Change in Workload	% Change in Cost per Procedure
Jun-03	$5,664.17	99	$57.21	Jun-04	$4,543.33	148	$3.84	-19.79%	49.5%	-93.3%
Jul-03	$5,326.18	106	$50.25	Jul-04	$5,933.04	153	$38.78	11.39%	44.3%	-22.8%
Aug-03	$1,449.76	111	$13.06	Aug-04	$4,791.78	152	$31.52	230.52%	36.9%	141.4%
Sep-03	$1,924.73	87	$22.12	Sep-04	$4,807.11	128	$37.56	149.76%	47.1%	69.8%
Oct-03	$10,834.07	104	$104.17	Oct-04	$4,340.27	114	$38.07	-59.94%	9.6%	-63.5%
Nov-03	$2,853.75	104	$27.44	Nov-04	$5,063.89	146	$34.68	77.45%	40.4%	26.4%
Dec-03	$7,270.89	100	$72.71	Dec-04	$7,365.36	160	$46.03	1.30%	60.0%	-36.7%
Jan-04	$3,379.30	102	$33.13	Jan-05	$7,340.00	165	$44.46	117.20%	81.8%	34.3%
Monthly Avg:	$4,837.86	102	$47.51	*Monthly Avg:*	$5,523.10	146	$34.37	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$685.24	44	-$13.14	14.16%	43.42%	-27.66%

OR	Monthly Total	OR Workload	Cost per Procedure	OR	Monthly Total	OR Workload	Cost per Procedure	Total % Change in Expense	% Change in Workload	% Change in Cost per Procedure
May-03	$44,259.64	91	$486.37	May-04	$36,605.08	105	$346.62	-17.29%	15.38%	-28.32%
Jun-03	$52,879.71	88	$600.91	Jun-04	$51,191.91	132	$387.82	-3.19%	50.00%	-35.46%
Jul-03	$48,893.54	89	$549.37	Jul-04	$50,065.24	123	$407.03	2.40%	38.20%	-25.91%
Aug-03	$39,642.83	95	$417.29	Aug-04	$98,548.39	126	$782.13	148.59%	32.63%	87.43%
Sep-03	$27,624.84	73	$378.42	Sep-04	$57,566.57	107	$538.01	108.39%	46.58%	42.17%
Oct-03	$25,247.12	82	$307.89	Oct-04	$34,816.25	105	$331.58	37.90%	28.05%	7.69%
Nov-03	$31,351.70	79	$396.86	Nov-04	$48,976.34	137	$357.49	56.22%	73.42%	-9.92%
Dec-03	$33,263.61	81	$410.66	Dec-04	$42,531.77	130	$327.17	27.86%	60.49%	-20.33%
Jan-04	$44,393.66	92	$482.54	Jan-05	$53,864.33	142	$379.33	21.33%	54.35%	-21.39%
Monthly Avg:	$38,617.43	86	$447.81	*Monthly Avg:*	$52,685.10	123	$428.80	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$14,067.67	37	-$19.01	36.43%	43.77%	-4.25%

ER	Monthly Total	Workload	Cost per Visit	ER	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Jul-03	$5,213.01	1058	$4.93	Jul-04	$5,436.89	1305	$4.17	4.29%	23.35%	-15.45%
Aug-03	$9,709.70	1260	$7.71	Aug-04	$12,180.62	1176	$10.36	25.45%	-6.67%	34.41%
Sep-03	$15,035.24	1266	$11.88	Sep-04	$9,203.86	1261	$7.30	-38.78%	-0.39%	-38.54%
Oct-03	$6,783.55	1287	$5.27	Oct-04	$8,301.76	1331	$6.24	22.38%	3.42%	18.34%
Nov-03	$2,287.53	1409	$1.62	Nov-04	$9,481.44	1290	$7.35	314.48%	-8.45%	352.72%
Dec-03	$11,380.21	1399	$8.13	Dec-04	$9,946.37	1412	$7.04	-12.60%	0.93%	-13.40%
Jan-04	$3,289.63	1250	$2.63	Jan-05	$10,979.11	1546	$7.10	233.75%	23.68%	169.85%
Monthly Avg:	$7,671.27	1276	$6.02	*Monthly Avg:*	$9,361.43	1332	$7.08	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$1,690.17	56	$1.06	22.03%	4.39%	17.51%

Family Practice	Monthly Total	Workload	Cost per Visit	Family Practice	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Jul-03	$3,973.89	2055	$1.93	Jul-04	$2,111.34	2010	$1.05	-46.87%	-2.19%	-45.68%
Aug-03	$2,828.73	1950	$1.45	Aug-04	$3,493.90	2717	$1.29	23.51%	39.33%	-11.35%
Sep-03	$1,423.97	1762	$0.81	Sep-04	$1,794.62	2285	$0.79	26.03%	29.68%	-2.82%
Oct-03	$1,179.58	1716	$0.69	Oct-04	$1,751.10	1994	$0.88	48.45%	16.20%	27.75%
Nov-03	$1,501.47	1077	$1.39	Nov-04	$2,290.37	2221	$1.03	52.54%	106.22%	-26.03%
Dec-03	$2,819.47	1604	$1.76	Dec-04	$2,242.25	2260	$0.99	-20.47%	40.90%	-43.66%
Jan-04	$1,653.43	1743	$0.95	Jan-05	$2,096.73	2461	$0.85	26.81%	41.19%	-10.19%
Monthly Avg:	$2,197.22	1701	$1.28	*Monthly Avg:*	$2,254.33	2278	$0.98	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$57.11	577	-$0.30	2.60%	33.94%	-23.44%

Monthly Expenditures Prior to Omnicell Implementation				Monthly Expenditures Post-Omnicell Implementation				Lower than Workload % is Good	Positive % Change is Good	Negative % Change is Good
OB/GYN	Monthly Total	Workload	Cost per Visit	OB/GYN	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Nov-03	$2,625.52	630	$4.17	Nov-04	$3,147.24	844	$3.73	19.87%	33.97%	-10.52%
Dec-03	$2,635.03	639	$4.13	Dec-04	$1,345.97	736	$1.83	-48.84%	15.18%	-55.67%
Jan-04	$2,001.59	586	$3.40	Jan-05	$2,537.85	705	$3.67	25.25%	19.90%	7.83%
Monthly Avg:	$2,421.05	619	$3.90	Monthly Avg:	$2,360.35	762	$3.08	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					-$60.69	143	-$0.82	-2.51%	23.05%	-21.10%

Med-Surg	Monthly Total	Bed Days	Cost per Bed Day	Med-Surg	Monthly Total	Bed Days	Cost per Bed Day	Total % Change in Expense	% Change in Workload	% Change in Cost per Bed Day
Aug-03	$2,623.44	95	$27.38	Aug-04	$3,024.95	141	$21.45	15.09%	46.85%	-21.64%
Sep-03	$5,545.25	113	$49.08	Sep-04	$2,615.15	165	$15.85	-52.85%	46.02%	-67.71%
Oct-03	$5,152.52	111	$46.42	Oct-04	$2,925.09	167	$17.52	-43.23%	50.45%	-62.27%
Nov-03	$2,674.72	124	$21.57	Nov-04	$2,687.02	161	$16.69	0.46%	29.84%	-22.63%
Dec-03	$4,670.02	87	$53.68	Dec-04	$4,425.83	165	$26.82	-5.23%	89.66%	-50.03%
Jan-04	$6,734.77	108	$62.36	Jan-05	$7,684.14	183	$41.99	14.10%	69.44%	-32.66%
Monthly Avg:	$4,567.79	107	$43.41	Monthly Avg:	$3,893.70	164	$23.39	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					-$674.09	57	-$20.03	-14.76%	53.68%	-46.13%

Ortho	Monthly Total	Workload	Cost per Visit	Ortho	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Dec-03	$4,518.79	536	$8.43	Dec-04	$5,072.85	645	$7.85	12.26%	20.34%	-6.71%
Jan-04	$18,393.13	533	$34.51	Jan-05	$4,054.76	793	$5.11	-77.96%	48.78%	-77.96%
Monthly Avg:	$11,455.96	535	$21.47	Monthly Avg:	$4,563.81	719	$6.49	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					-$6,892.16	186	-$14.98	-60.16%	34.52%	-69.78%

General Surgery	Monthly Total	Workload	Cost per Visit	General Surgery	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Dec-03	$716.16	132	$5.43	Dec-04	$658.90	208	$3.17	-8.00%	57.58%	-41.61%
Jan-04	$646.38	94	$6.88	Jan-05	$791.95	160	$4.95	22.52%	70.21%	-28.02%
Monthly Avg:	$681.27	113	$6.15	Monthly Avg:	$725.43	184	$4.06	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$44.16	71	-$2.09	6.48%	62.83%	-34.01%

Same Day Surgery	Monthly Total	Workload	Cost per Visit	Same Day Surgery	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Dec-03	$1,444.38	68	$21.24	Dec-03	$1,279.05	83	$15.41	-11.45%	22.06%	-27.45%
Jan-04	$1,430.84	86	$16.64	Jan-04	$658.43	111	$5.93	-53.98%	29.07%	-64.35%
Monthly Avg:	$1,437.61	77	$18.94	Monthly Avg:	$968.74	97	$10.67	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					-$468.87	20	-$8.27	-32.61%	25.97%	-43.66%

Mother Baby	Monthly Total	Bed Days	Cost per Bed Day	Mother Baby	Monthly Total	Bed Days	Cost per Bed Day	Total % Change in Expense	% Change in Workload	% Change in Cost per Bed Day
Jan-04	$12,632.52	111	$115.61	Jan-05	$15,326.14	212	$77.01	27.22%	90.99%	-33.39%
Average Monthly Difference Between Prior and Post-Omnicell:					$3,493.62	101	-$38.60	27.22%	90.99%	-33.39%

The data source for the *monthly total* expense data in Table 3 was the DMLSS system. The *prior to Omnicell implementation* data served as the baseline for which to compare the *post-Omnicell implementation* data to. For example, in the case of the OR, the data collection time period was from May 2004 through January 2005. Therefore, the corresponding calendar months from the previous year, May 2003 through January 2004, were used as the baseline for comparison of prior to Omnicell data. All months displayed in the comparison analysis are complete months of data. Therefore, if a customer's Omnicell full implementation began in the middle of a month, that month was not analyzed. Table 3 separates each customer and its corresponding monthly analysis. The three columns which serve as the basis for comparison throughout Table 3 are: *Monthly Total, Workload* or *Bed Days,* and *Cost per Visit/Procedure/Bed Day.* Each customer's cost per visit was calculated by dividing the monthly total supply expense (from DMLSS) by the workload for that month. Below the monthly totals for each customer is a row labeled *Monthly Avg.* This row contains the monthly averages for the columns: monthly total, workload or bed day, and cost per visit/procedure/bed day. The last row for each customer's comparison analysis in Table 3 contains the *Average Monthly Difference Between Prior and Post-*Omnicell expenses and workload. Each customer's values in this row were calculated by subtracting its prior to implementation monthly average from its post-implementation average in the monthly total, workload, and cost per visit columns. Thus, a positive value in this row indicates an increase since implementation; similarly, a negative value indicates a decrease in the average monthly expense by that amount since Omnicell implementation.

Table 4 provides an illustration of a customer's results from the comparison analysis. The *average monthly difference between prior and post-Omnicell* row reveals that when comparing the months since implementation to its corresponding months prior to implementation, the MSU is spending an average of $674.09 less monthly, while its monthly number of patient bed days has increased by an average of 57 bed days, resulting in a decrease in cost of $20.03 per bed day. These results are very favorable because not only is the MSU spending less per bed day, its monthly total expenses have decreased as a whole despite an increased number of total bed days.

Table 4

MSU monthly comparison financial analysis

Monthly Expenditures Prior to Omnicell Implementation				Monthly Expenditures Post-Omnicell Implementation				Lower than Workload % is Good	Positive % Change is Good	Negative % Change is Good
Med-Surg	Monthly Total	Bed Days	Cost per Bed Day	Med-Surg	Monthly Total	Bed Days	Cost per Bed Day	Total % Change in Expense	% Change in Workload	% Change in Cost per Bed Day
Aug-03	$2,623.44	96	$27.38	Aug-04	$3,024.95	141	$21.45	15.09%	46.88%	-21.64%
Sep-03	$5,545.25	113	$49.05	Sep-04	$2,615.15	165	$15.85	-52.85%	46.02%	-67.71%
Oct-03	$5,152.52	111	$46.42	Oct-04	$2,925.09	167	$17.52	-43.23%	50.45%	-62.27%
Nov-03	$2,674.72	124	$21.57	Nov-04	$2,687.02	161	$16.69	0.46%	29.84%	-22.63%
Dec-03	$4,670.02	87	$53.68	Dec-04	$4,425.33	165	$26.82	-5.23%	89.66%	-50.03%
Jan-04	$6,734.77	106	$62.36	Jan-05	$7,684.14	163	$41.99	14.10%	69.44%	-32.66%
Monthly Avg:	$4,567.79	107	$43.41	*Monthly Avg:*	$3,893.70	164	$23.35	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					-$674.09	57	-$20.03	-14.76%	53.68%	-46.13%

The last three columns on the right of Table 4 are the main indicators of success in this analysis when determining the cost savings resulting from Omnicell implementation. These columns are as follows: *total % change in expense, % change in workload,* and *% change in cost per visit/bed day.* To facilitate understanding the table's results, any box with an "unfavorable" value—in the three % change columns—has been darkened (with the numbers appearing in white font). The total % change in expense is simply calculated as the percentage of the increase or decrease in total supply expenditures when comparing the post-implementation month with the corresponding prior to implementation month. For example, as depicted in Table 4, a -43.23% change in the comparison row of *Oct-03* with *Oct-04* means that the customer spent 43.23% less in Oct-04 than it did in Oct-03. Had the comparison shown an increase in spending, the increase in spending is not necessarily an unfavorable response. For this reason, the column % change in workload was added to the analysis. This column shows the % change in workload from prior to implementation with post-implementation. Using

Table 4 as an illustration, a value of 69.44% in the row comparing *Jan-04* with *Jan-05* demonstrates a 69.44% increase in workload in Jan-05 from Jan-04. Consequently, only by analyzing columns total % change in expense and % change in workload together can one make a determination if Omnicell is decreasing expenses. A favorable outcome results when the total % change in expense column values are lower than their corresponding month's % change in workload values. Using Table 4 as an example, the MSU's average monthly percent change in expense for the total period of analysis was -14.76% (a decrease of 14.76%), and its average monthly percent change in number of bed days was an increase of 53.68%. This demonstrates a positive outcome of Omnicell implementation because the percent change in expense was lower than the percent change in workload. Similarly, a favorable outcome can be realized even when monthly expenses have increased since Omnicell implementation. For example, if monthly expenses increased by 18% but workload increased by 25% concurrently, a favorable outcome is realized. Therefore, a favorable outcome occurs when the total percent change in expenses increases at a lesser rate than the total percent change in workload.

The best measure of Omnicell's cost savings is the far right column, *% Change in Cost per Visit/Procedure/Bed Day*. The % change in cost per visit reflects the change in cost per visit—as a percentage—from the prior to implementation period to the corresponding post-implementation period. As in Table 4, *Sep-03* to *Sep-04* contains a value of -67.71% in the % change in cost per bed day column. This signifies that the cost per bed day decreased by 67.71% in Sep-04 (post-implementation) from Sep-03 (pre-implementation). In this column, a favorable result is only a negative percentage value because this represents a decrease in cost per visit. The bottom right-hand box of each customer's analysis contains the overall average percent change in cost per visit for the period of analysis (see Table 3). Using Table 4 as an illustration, in the case of the MSU, its average monthly percent change in cost per bed day was -46.13%. Consequently, one can conclude that for the period of analysis following Omnicell implementation, the cost per bed day decreased by an average of 46.13% when comparing that to the cost per bed day for the corresponding time period of analysis prior to Omnicell implementation.

The results in Table 3 demonstrate that 9 out of the 10 customers with Omnicell yielded favorable financial outcomes in both cost savings indicators—total % change in expense being lower than % change in workload and a decrease in % change in cost per visit.

The next financial outcomes being analyzed are the one-time cost avoidances for HMEDDAC resulting from the excess inventory turned in by each customer prior to its Omnicell implementation and maintained by the medical warehouse for resale to the customer. The dollar values of excess inventory that were turned in by the customers and retained by the medical warehouse for resale to the customers are displayed in the left column of Table 5. The data for these amounts came from the DMLSS and is based on the actual inventory that was turned in to the medical warehouse and inputted into DMLSS for credit to the medical warehouse, classifying it as a *gain* for its inventory. The values in Table 5 do not include the inventory turned in to the Defense Reutilization and Marketing Office (DRMO). The inventory turned in to DRMO during the initial implementation turn-in are classified as waste and do not result in a cost savings for HMEDDAC.

The right column of Table 5 lists the dollar values for each customer's Omnisupplier on *Day 1*, the date of Omnicell activation for each customer. These values are classified as cost avoidances for HMEDDAC because each Omnisupplier's original inventory on the date of activation came from the inventory retained by the customer. The *Day 1 Inventory Values* in Table 5 were pulled from HMEDDAC's Omnicell database based on Omnicell's cost data and inventory count.

Table 5

One-time cost avoidances resulting from customer excess inventory

Excess Inventory Turned in by Customers and Retained by Medical Warehouse for Resale		Day 1 Inventory Values
Anesthesia	$58,188.97	$8,681.23
Operating Room	$306,814.31	$348,565.25
Emergency Room	$11,577.51	$24,665.10
Family Practice	$31,129.74	$11,694.16
Mother Baby	$6,381.25	$14,109.21
Med-Surg	$6,701.45	$10,955.94
OB/GYN	$5,719.30	$10,823.37
Orthopaedics	$20,293.68	$11,414.97
Same Day Surgery	$853.58	$1,651.38
Total:	$447,659.79	$442,560.62

Besides the positive quantitative benefits Omnicell implementation has achieved, the implementation has facilitated several qualitative benefits. These qualitative benefits include improvements in the following areas: supply consumption tracking, reporting and analysis capabilities, pharmacy medication management and accountability of pharmaceuticals, time savings, and customer satisfaction.

Discussion

Quantitative Benefits

Cost savings.

As Table 3 shows, Omnicell is decreasing the cost per visit for HMEDDAC's customers with Omnicell cabinets. Clearly, Omnicell's implementation has decreased the costs per visit for HMEDDAC customers with Omnicell; and in some cases, it has even facilitated a decrease in average total monthly expenses. Additionally, the results show that Omnicell customers have maintained their increasing rate of expenses below that of their corresponding increasing workload rates. The 90% success rate achieved during the period of analysis (see Table 3) confirms a cost savings for HMEDDAC.

The emergency room is the only customer who did not see a decrease in cost per visit during the period of analysis. The final results for the period of analysis for the ER indicate that it has increased its average monthly expenses by $1,690.17, while workload has increased by 56 visits, resulting in an average increase in cost per visit of $1.06. In terms of percentages, the ER's expenses increased by 22.03% with only a 4.39% increase in workload, resulting in an increased cost per visit of 17.51%. Table 6 displays the complete analysis for the emergency room.

Table 6

ER monthly comparison financial analysis

Monthly Expenditures Prior to Omnicell Implementation				Monthly Expenditures Post-Omnicell Implementation				Lower than Workload % is Good	Positive % Change is Good	Negative % Change is Good
ER	Monthly Total	Workload	Cost per Visit	ER	Monthly Total	Workload	Cost per Visit	Total % Change in Expense	% Change in Workload	% Change in Cost per Visit
Jul-03	$5,213.01	1058	$4.93	Jul-04	$5,436.88	1305	$4.17	4.29%	23.35%	-16.45%
Aug-03	$9,709.70	1260	$7.71	Aug-04	$12,180.62	1176	$10.36	25.45%	-6.67%	34.41%
Sep-03	$15,035.24	1266	$11.88	Sep-04	$9,203.86	1261	$7.30	-38.78%	-0.39%	-38.54%
Oct-03	$6,783.55	1287	$5.27	Oct-04	$8,301.76	1331	$6.24	22.38%	3.42%	18.34%
Nov-03	$2,287.53	1409	$1.62	Nov-04	$9,481.44	1290	$7.35	314.48%	-8.45%	352.72%
Dec-03	$11,380.21	1399	$8.13	Dec-04	$9,946.37	1412	$7.04	-12.60%	0.93%	-13.40%
Jan-04	$3,289.63	1250	$2.63	Jan-05	$10,979.11	1546	$7.10	233.75%	23.68%	169.85%
Monthly Avg:	$7,671.27	1276	$6.02	*Monthly Avg:*	$9,361.43	1332	$7.08	Average Monthly % Change		
Average Monthly Difference Between Prior and Post-Omnicell:					$1,690.17	56	$1.06	22.03%	4.39%	17.51%

On the surface, the results from Table 6 appear to be unfavorable, with four out of seven months of comparison being unfavorable; however, these results confirm the poor supply management practices of the ER prior to Omnicell implementation. With both the before and after Omnicell implementation ER workload averages being about the same in the comparison months, one would expect about the same expenses; however, his is not the case for the ER. Since Omnicell implementation, it is apparent what the true cost per visit is in the ER. This will make forecasting future expenses a much easier task than before.

Since its implementation of Omnicell (see Table 6), the ER's monthly total expenses have ranged between $8,000 and $11,000 during five out of the seven months of post-implementation analysis. In the comparison months before Omnicell, only three out of seven months of expenses were in the same range. Although its prior to Omnicell expense fluctuations were significant, the outlier months cause the ER's pre-Omnicell cost per visit to appear low. As Table 6 demonstrates, in *Nov-03*, the ER spent $2,287.53 with a workload of 1409. Similarly, in *Jan-04*, the ER spent $3298.63 with a workload of 1250; however, it spent $11,380.21 on 1399 visits in *Dec-03* and $15,035.24 on 1266 visits in *Sep-03*. These large fluctuations confirm that the ER's supply management practices were not based on actual demand. The ER staff appears to have stockpiled in certain months and survived off of the excess inventory in subsequent months, making it impossible to obtain an accurate assessment of a true cost per visit for each month and even more difficult to forecast expenses. Except for July and August 2004, following Omnicell implementation in the ER, monthly costs per visit have been consistent, with costs ranging from $6.24 to $7.35 (see Table 6). This is a considerable difference from the wide range in cost per visit of its corresponding pre-Omnicell months, ranging between $1.62 and $11.88 (see Table 6). Consequently, based on the trend since its Omnicell implementation, the ER can reasonably forecast its monthly expenses based on the consistent patterns in cost per visit it has demonstrated. This should result in true cost savings due to the lack of considerable expense fluctuations seen prior to Omnicell implementation.

Excess inventory turn-in and usage.

Besides looking at the monthly comparison data, Omnicell's one-time cost savings also validate HMEDDAC's investment in Omnicell's automated POU equipment. Table 5 displays the surplus inventories turned in by customers to the medical warehouse prior to their individual Omnicell activation dates. These values are cost avoidances because the medical warehouse used this turned-in stock to replenish par levels for the customer based on actual POU consumption following Omnicell's implementation. Although the customer was charged in DMLSS for these post-Omnicell replenishments that came from this inventory, these charges were cost avoidances for HMEDDAC because the warehouse had maintained the turned-in excess inventory on its shelves and classified them as gains in DMLSS prior to reissuing these supplies. Consequently, the warehouse did not need to purchase these excess line items until they were expended. Additional cost avoidances for HMEDDAC were realized from each customer's Omnisupplier Day 1 inventory values (see Table 5). Since virtually all the Day 1 inventory had already been purchased by HMEDDAC and retained by customers for initial par levels, additional stock did not need to be purchased for the initial activation of the Omnisuppliers. Thus, the warehouse avoided purchasing and charging this inventory to the customer.

In spite of the cost avoidance resulting from retained excess inventory, the inventory manager estimates that over $200,000 of inventory had been turned in to DRMO as waste during the initial customer inventory turn-ins. The majority of this stock had been purchased during previous fiscal years, and it is Army policy that supplies are to be purchased and consumed in the same fiscal year. Clearly, with such observable excesses in stock, this practice had not been occurring in the majority of customers' supply rooms prior to Omnicell. In the case of the OR, an estimated 40% of all excess inventories the OR turned in were not retained and immediately turned in to DRMO because the items were either expired, obsolete, or were chosen to never be ordered again. Consequently, one benefit from Omnicell is that it has facilitated standardization of several medical supplies now that the Logistics Division can truly monitor inventory levels by line item. Additionally, this has resulted in a large amount of obsolete items being turned in to DRMO because they would not be ordered again. Since implementation, out of the over $447,000 of excess inventory that was retained by the medical warehouse, some of that inventory has since been turned in to DRMO due to the expiration or non-usage of that inventory. While a precise estimate of this amount cannot be given, the warehouse estimates that in excess of $150,000 of the initial retained inventory has since been turned in to DRMO as waste. As a result, HMEDDAC did not completely avoid the expenditure of the total retained $447,000 in medical supplies; however, an estimated $297,000 of that amount is a true cost avoidance for HMEDDAC and further validates purchasing the Omnicell equipment.

Increased reimbursements.

Another quantitative benefit of implementing Omnicell comes from its ability to substantially increase reimbursements with its capability to capture and assign billable supplies to individual patients. This capability also results in the elimination of lost charges for the Omnicell customers within HMEDDAC. Omnicell's ability to interface with billing systems that link supplies with charges allows hospitals to generate itemized bills in the outpatient, surgical, and inpatient settings. Two reports generated by Omnicell that contain itemized patient consumption are the *Patient Billing by Payor Report* and *Transactions by Patient* reports. Although HMEDDAC has not interfaced Omnicell with the billing system of this facility, this analysis originally proposed to forecast increased reimbursements that itemized billing would generate for the hospital based on the five case supply lists and average case loads for those cases. Due to the analysis limitation resulting from the current inability to associate charges with specific medical supplies, the proposed itemized billing comparison analysis and reimbursement forecasts cannot be performed at this time.

In the APV/surgical and inpatient settings, itemized billing is not possible until the DoD methodology changes and allows for it. Additionally, before itemized billing can be accomplished, the DoD must create a *charge description master* (CDM), a list that details the rates for each type of or specific medical supply. Subsequently, this CDM must be embedded in the billing module of CHCS. Therefore, without this CDM and DoD policies allowing for itemized billing of medical supplies, Omnicell's ability to interface and create itemized bills through CHCS is not possible and the reimbursement gains cannot be realized. Nevertheless, since HMEDDAC has the equipment to capture supplies and equipment consumed on individual patients, the hospital is ready to employ itemized billing immediately following the DoD's implementation. Appendix A contains an example of a Patient Billing by Payor Report that could be used with an itemized billing interface when the billing capabilities are developed and DoD policies make it possible.

Qualitative Benefits

Supply consumption tracking.

Omnicell can track case-based utilization, unit-based utilization, and physician supply utilization as it is related to a patient's use and charge recovery (Hofer, 2001). Besides allowing for itemized billing of patients, consumption tracking presents other benefits as well. One of the most important benefits of tracking supplies is that it allows for a true understanding of the cost of doing business. As DoD health care delivery contracts and requirements change, increasing financial responsibility is being placed on MTF commanders to reduce costs and increase access for their beneficiary populations. Commanders will be required to fund the care for their beneficiaries whose procedures are performed by local providers outside of the MTF. Therefore, commanders will be required to make important decisions regarding whether to provide certain services or procedures within the MTF or whether to send those services or procedures outside of the MTF. Without knowing the true cost of business within his facility, the commander cannot make these informed decisions.

Although Omnicell can accurately capture specific costs and transactions by procedure, diagnosis, physician, cost center, and by cost per patient day, the onus of accurately capturing these costs falls on the users. When users take items from the Omnicell cabinet and charge these items to floor stock (as opposed to a specific patient), these lost charges make it virtually impossible to capture the *true* costs of doing business (i.e. cost per procedure, physician, diagnosis, patient day). Medical supply consumption costs can only be captured when users link consumption to the specific patient on whom the supplies are expended. Therefore, as far as the medical supply consumption is concerned, Omnicell has the capability to identify the true costs of doing business, but only if supplies are properly charged to the right patient. Understanding these costs allows the commander to make an informed decision on whether it is more cost-effective to continue providing certain services in-house or to purchase those services from the network.

Tracking consumption of supplies by physician and procedure allows for the establishment of best practices and practice standardization within the facility. For example, a surgical service chief could look at the supplies each surgeon uses for a specific type of case and then examine the practice variations between his surgeons. This might result in the discovery of certain practices that should or should not continue so as to minimize practice variations. An added benefit that Omnicell provides is increased supply accountability. Because Omnicell provides complete accountability, users are more aware of how they use supplies; this naturally reduces the amount of waste, leading to cost savings ("Improving Inventory Control," n.d.).

Reporting and analysis capabilities.

Another qualitative benefit that Omnicell provides HMEDDAC comes from its reporting and data analysis capabilities that result from its accurate consumption tracking and increased accountability of supply usage. Because the reports generated by Omnicell's database can be exported into Excel, HMEDDAC can perform various types of analyses of usage patterns for the benefit of improving supply management efficiency and organizational effectiveness within the hospital. Two of the most informative reports are the Par vs. Usage and Transactions by Date reports. The Par vs. Usage report (see Appendix B) allows for the analysis of which items are moving and not moving, and to what extent these items have been consumed. Some of the lists generated by the report include: the average daily usage for each item, number of *critically low* (on-hand quantity below reorder point) days for each item, par values of non-moving items, total number of *stockouts* (on-hand quantity of zero) and average number of stockouts for specific items. Through a par level analysis, an analyst can determine to what extent the par levels, reorder points, and/or intervals between restocks should be based on number of stockouts or because of lack of usage. Adjusting reorder points and delivery schedules through regular analysis can yield remarkable efficiency improvements and minimize the number of detrimental stockouts.

The Transactions by Date report (see Appendix C) is another useful Omnicell generated report that allows customers to track user specific consumption as well as monitor user compliance patterns. This report details to what extent specific users are pulling items out as floor stock or whether they are assigning consumption to specific patients by name. Subsequently, an analyst can consolidate a customer's total lost charges and determine the lost charges as a percentage of total consumption. Managers can utilize this report to determine which users need improvement on charging supplies to the patient instead of floor stock, resulting in substantial reductions in lost charges for HMEDDAC. In turn, this increased charge recapture would allow for greater reimbursements once itemized billing is established. In addition to tracking lost charges, the Transactions by Date report also serves as a user accountability tool. For example, Omnicell creates user specific reports that can identify *abusers* who are generating null transactions. Null transactions occur when a user selects a patient or floor charge, then opens the door, but does not push any button. The Omnicell cabinet was opened but is unaware which items, if any, were pulled. These null transactions create inventory discrepancies and most assuredly lead to preventable stockouts. When managers review reports containing null transaction information, they can target specific users who require improvements in supply issuing procedures or additional training in use of the equipment.

Omnicell provides several other reports that can be used for analysis and continuous efficiency improvements for HMEDDAC's supply management. A list containing several of the reports that Omnicell's database can generate and a brief description of each report and its use is displayed in Appendix D.

Pharmacy benefits.

Omnicell has produced many qualitative benefits to the pharmacy and pharmaceutical distribution as well. According to the Institute for Safe Medication Practices, automated pharmacy systems are one of the best investments a hospital can make in promoting medication safety and efficiency ("Integrated Automation Helps," n.d.). Several efficiencies in ordering pharmaceuticals for the inpatient wards and outpatient clinics with pharmaceuticals have been improved upon. One such improvement is the unit of issue being broken down to its lowest level for the resupply of pharmaceuticals. Since the units of issue now are by the milliliter or individual pill, this form of distribution cuts down on waste and improves the efficiency of distributing pharmaceuticals. Prior to Omnicell, nurses generated orders through CHCS by vials, bottles, or larger amounts; since Omnicell's implementation, order requests are generated automatically by Omnicell and sent to the pharmacy for restock by pharmacy personnel. This process has, in effect, streamlined the hospital's medication ordering and dispensing process, resulting in efficiency improvements in ordering and timeliness of resupply.

Omnicell's POU medication management is also making improvements to patient safety within HMEDDAC. The patient medication profiling feature is one of its key benefits to patient safety. This feature utilizes an interface with the facility's pharmacy information system within CHCS to display the patient's complete medication profile on the cabinet's screen at the point of care. This feature allows pharmacists to review information on dosage, administration, contraindications, drug interactions, and patient drug allergies prior to the drug being dispensed from the Omnicell cabinets on the nursing units ("Automated Pharmacy Dispensing," n.d.). The medication profiling feature allows access to medication orders only after they have been reviewed and approved by the appropriate health care professional ("Shortage Spurs Automation," n.d.). The JCAHO standards require a pharmacist's—or licensed independent practitioner's—review of medication orders prior to dispensing the first dose. As a result, this feature provides inpatient caregivers an additional safety control for dispensing pharmaceuticals and assists HMEDDAC in its efforts to comply with JCAHO pharmacy standards and regulations.

Omnicell contains other patient safety controls as well that assuredly result in a decline in potential medication dispensing and administration errors ("Integrated Automation," n.d.). One of these controls is Omnicell's *guiding light* technology. Once a user chooses which medication to pull, the specific drawer light comes on and the exact bin which holds the selected medication lights up as well. This technology quickly directs users to the location of specified medications to reduce potential medication errors. Additionally, some cabinets are equipped with sensing drawers which have alarms that sound if the wrong bin is opened. These drawers are ideal for high-distraction areas, such as the ER, where the potential for drug dispensing errors is particularly high ("Reducing Medication Errors," n.d.). Another safety control is Omnicell's expiration tracking and reporting feature. For this feature to be effective, the pharmacy technicians must enter the expiration dates of the medications into the Omnisupplier while they restock the cabinets. Whenever a user accesses a tracked item, the expiration date will appear; if an item has expired, a warning message is displayed on the screen. The expiration date tracking is an excellent safety feature, as it allows users to be aware of and find expired medications so that they are not dispensed to patients.

Because the Omnicell has internet connectivity, patient safety is enhanced through an integrated Web browser that gives users quick and easy access to pharmacological information, providing nurses with the information needed to safely administer and monitor medications. The information database provides current drug information, color photos of medications and complete text information within the following menus: patient education, indications/dosage, drug administration, contraindications, interactions, adverse reactions, chemical structures, and costs.

Besides facilitating patient safety, Omnicell aids in the security and accountability of medications. This comes in the form of access controls, locked drawers and bins, and user accountabilities. Section chiefs or head nurses control user access levels for their subordinate users to restrict access to controlled substances and narcotics to only those personnel who are authorized access to them. Even for staff with narcotics access, Omnicell drawers equipped with individually locked bins remain locked at all times and only allow access to the specific requested narcotic. Additionally, each time a narcotic is pulled, Omnicell requests a physical count of that narcotic. If the amount is different than the last reported quantity, a discrepancy report is generated with the name of the last three personnel who pulled that narcotic as well as what the count should be. The staff member must then perform an inquiry to resolve the discrepancy. Additional accountability occurs through Omnicell's recording of every user transaction, including when users open medication bins other than the requested bins or perform null transactions. Clearly, these control features improve narcotics control and decrease the incidence of missing medications ("The Rewards," n.d.).

Time savings.

Another qualitative benefit that has resulted since the implementation of Omnicell is the time savings for the clinical customers, who prior to Omnicell, had dedicated time to supply management. With the implementation of Omnicell's automated POU equipment, inventory is no longer ordered manually through DMLSS by clinical personnel. Once stock levels reach established reorder points for each item, those items stocked in the Omnicell cabinets are automatically reordered through a DMLSS interface, and the list is forwarded to the medical warehouse. Time savings for customers have also occurred with the medical warehouse's change in operating procedures from requiring clinical personnel to stock their own shelves, to designating the responsibility of delivering supplies and stocking the Omnicell cabinets solely to the logistics' supply specialists. Time previously consumed by supply management is now available for customers to use more effectively. Before Omnicell implementation, pharmacy orders for ward stock were inputted manually by nursing personnel into CHCS; following Omnicell implementation, pharmacy orders are generated and transmitted to the pharmacy automatically through an interface with CHCS when the pharmaceuticals reach their specific reorder points.

Omnicell is yielding time savings in other areas as well. One example has been demonstrated in the OR, where prior to the installation of the Omnicell equipment, one full-time equivalent OR technician was responsible for the supply management of the OR. Since implementation, however, that OR technician's time dedicated to supply management has been reduced to an average of only sixteen hours a week, freeing him to assist the surgeons in the operating room. Another example of time savings in the OR comes from the creation of customized case kits—based on preference cards by case and/or physician—within the Omnicell cabinets. When a user pulls a specific case kit based on the case and surgeon preferences, the cabinet doors unlock, along with the corresponding lights for the shelf items that needs to be removed. Then, the individual lights turn off as the user pushes the "take" button while removing the items. Indeed, pulling and searching for individual items listed on a preference card consumes more time than utilizing Omnicell's case kit feature.

Lastly, the ability of Omnicell's CHCS interface to upload patient names to the Omnisuppliers generates time savings for customers. For example, when a patient is admitted into the facility, the patient is automatically uploaded into the Omnicell through the interface so that the user is not required to manually enter the patient information before pulling medical supplies for the patient, a process that could take from three to five minutes per patient. Therefore, although it requires users more time for each transaction (pulling individual supplies from the cabinets), overall net gains in time are realized for the customers due to the seamless supply chain management now employed with the Omnicell equipment.

Customer satisfaction.

The supply management provided by Omnicell's automated POU equipment has increased customer satisfaction as well. Since Omnicell's implementation has removed the function of supply management from clinical personnel, there has been a reduction in errors due to the misunderstanding of unit of issue sizes by customers who are not adequately trained in logistics management. Similarly, the medical warehouse has gained trust from its customers as a result of increasing its delivery schedules for timely restock of supplies to meet the customers' needs. Additionally, HMEDDAC is establishing a more accurate demand history with USAMMCE due to the bona fide demand-based procurement that automated POU supply management provides. Increased supplier reliability in the form of the medical warehouse's effectiveness at meeting the demands of the customers has increased customer satisfaction as well. This increased reliability is the result of the medical warehouse's increasing of stocked line items from about 100 lines to over 1100 lines. Maintaining these on-hand line items facilitates the immediate availability of inventory for use in restocking the Omnicell cabinets, since the items stocked in the customer cabinets are carried by the medical warehouse. This has eliminated the ability for customers to stockpile, allowing HMEDDAC to use its resources to meet more appropriate and timely needs.

On the surface, it appears that stockpiling inventory has shifted from the customer storerooms to the warehouse (since it now maintains inventory for all line items stocked within the Omnicell cabinets); however, this is not the case. As discussed, the total number of line items carried within the facility has been reduced with the implementation of Omnicell. Prior to Omnicell, each customer had the ability to stockpile line items that may have been stockpiled by other customers as well, with the inventory control section being unaware of the on-hand quantities and number of line items carried within HMEDDAC. With the warehouse now controlling supply management, the line items stocked in the warehouse have much lower inventory levels than the customers maintained when they managed the stock levels of their on-hand line items. Inventory levels have decreased significantly as a result of the warehouse's consolidation of similar line items stocked by multiple customers. Additionally, to maintain minimal inventory required to meet ongoing demand, the warehouse utilizes par levels and specific reorder points within DMLSS for its stocked line items. Therefore, the warehouse's improved efficiency of supply management of line items has substantially reduced inventory levels within HMEDDAC.

Clearly, the qualitative benefits provided from the implementation of Omnicell have benefited patient care in HMEDDAC due to the improvements in operational efficiencies for customers and enhancements in organizational effectiveness for HMEDDAC.

Limitations of the Study

Although the post-Omnicell implementation analysis yielded positive quantitative and qualitative results, several limitations were identified, resulting in an inability to document more definitive quantitative results. First, based on implementation dates occurring late in the period of analysis, limited time with some Phase II and all Phase III customers did not allow for an adequate baseline of post-Omnicell financial analysis because of the few months of available post-implementation data. Specifically, 5 out of the 10 customers who have implemented Omnicell had fewer than six months of post-implementation data during the period of analysis. Second, because the inventory control section did not have an accurate assessment of the number of on-hand line items or inventory levels of customers prior to the implementation of Omnicell, a comparison of pre and post-implementation on-hand inventory could not be performed. Third, the tracking of turned-in medical supply and pharmaceutical items is also a limitation for the analysis. Additionally, the lack of documentation did not provide accurate information necessary to quantify the dollar value of inventory turned in to DRMO. Consequently, only estimates can be provided for the initial DRMO turn-ins as well as continued turn-ins that took place during the period of analysis. Therefore, this limitation does not allow for final cost avoidance figures to be presented in this analysis.

Similar to the medical warehouse, prior to the implementation of Omnicell, the pharmacy did not tie cost to wasted medications. Before Omnicell pharmacy cabinets were installed, the expiration dates of medications issued to the wards and clinics were not tracked. When medication expired in the facility, the customer would either discard the medication or turn it in to the pharmacy for destruction. Regrettably, the pharmacy did not document or quantify the value of the destroyed medications. Although the pharmacy has since established a turn-in accountability program, the lack of expired medication data prior to Omnicell implementation does not allow for a comparative analysis as to whether Omnicell is facilitating a decrease in expired medications due to the reduced on-hand quantities and expiration date tracking capabilities that Omnicell provides.

Another limitation in the analysis was the unknown number of unrecorded transactions that occurred during the period of analysis, affecting the reliability of the post-Omnicell implementation financial data. The two types of unrecorded transactions were warehouse returns and non-routine supply issues. Discrepancies in customers' on-hand stock levels occurred as a result of users not pushing the *return* button in the Omnicell cabinet when removed supplies are returned back to the cabinet by the user. This discrepancy causes the warehouse supply technicians to take excess stock to the customers. After the supply technicians returned the excess stock to the warehouse, many returns were not processed and recorded correctly to issue credit to the customers in DMLSS. Therefore, because customers were charged for items that they should have received credit for when the items were returned to the warehouse, customers may have actually decreased spending in medical supplies to a greater extent, after Omnicell implementation, than was recorded in DMLSS. Discrepancies also occurred when users remove items from the Omnisupplier without pushing the *take* button, causing needless stockouts. As a result, customers require *urgent-non-routine issues* of supplies. Urgent-non-routine issues are unscheduled supply deliveries or customer pick-ups that occur as a result of a stockout for a particular item. These urgent-non-routine issues are not always documented by warehouse personnel and consequently not charged to the customer in DMLSS. Consequently, these unrecorded warehouse returns and non-routine issues have affected the reliability and validity of the post-implementation financial data.

Conclusion and Recommendations

Conclusion

Based on the quantitative and qualitative benefits that have been discussed in this analysis, it is clear that purchasing Omnicell was well worth the investment. The just-in-time inventory management provided by Omnicell's automated point-of-use equipment has facilitated cost savings since its implementation and will continue to validate its worth for HMEDDAC with continued cost savings. Additionally, the qualitative benefits that Omnicell implementation provides HMEDDAC has led to unmistakable improvements in supply management efficiency and enhancements in organizational effectiveness.

Although purchasing additional Omnicell equipment within HMEDDAC would yield increased efficiencies in supply chain management, investing in Omnicell expansion within HMEDDAC is not recommended. The Logistics Division's pre-purchase analysis and phased implementation allowed for HMEDDAC's customers with the highest consumable supply expenditures to benefit from the installation of Omnicell's automated POU equipment. Due to consistent high demand on HMEDDAC's resources, it would not be advantageous to invest in the infrastructure necessary to install additional Omnicell equipment for those customers with reasonably low supply expenditures. Additionally, HMEDDAC should not expand its Omnicell infrastructure due to the changing mission and realignment of Army forces taking place in the European Theater of Operations, with the likelihood of relocating the Army forces from Heidelberg within the next ten years. As a result of changing mission requirements at the Army level, the HMEDDAC command team is investigating several courses of action in relation to the hospital's evolving mission and force structure requirements. One of these courses of action is a reduction in inpatient services and surgical capabilities within the next few years. Reducing inpatient and surgical capabilities would allow for the reallocation of numerous Omnicell cabinets within the facility, expanding the capabilities of the Omnicell equipment to other customers within the facility and making the purchase of additional equipment superfluous. Therefore, additional resources should not be committed to expand Omnicell; however, HMEDDAC should monitor and continue evaluation of Omnicell's benefits to explore expansion of Omnicell within HMEDDAC should resources become available.

Recommendations

This paper serves as an application and baseline tool for future research and analysis to further evaluate the continued quantitative and qualitative benefits of Omnicell within HMEDDAC. First and foremost, the Logistics Division should utilize Omnicell's reporting capabilities to conduct analyses that will continually improve supply management efficiencies for its customers. Specifically, the inventory management section should use reports like the par vs. usage report to analyze stockouts and usage trends for active and inactive items to calculate optimal par levels and reorder points for inventory, ultimately reducing stockouts and increasing operational efficiencies for customers. Since half the customers with Omnicell had fewer than six months of post-implementation analysis, and all customers had fewer than twelve months, the methodology utilized for this analysis can be repeated to increase the reliability of the results by conducting similar quantitative analysis after the Phase III customers have at least 12 months of post-implementation data available. This analysis would determine if Omnicell is continuing to produce cost savings for the facility. These analyses, and continued monitoring of monthly expenditures, may also assist the Logistics Division in determining if Omnicell cabinets need to be redistributed and where they should be redistributed to. For example, based on expenses from services like General Surgery and Same Day Surgery, cost savings achieved and efficiency benefits gained may not exceed the resources committed to acquire the Omnicell equipment. Rather, HMEDDAC may reap more benefits from the cabinets if they were moved to a higher expense customer like Pediatrics or to expand capabilities in the Emergency Room or Mother-Baby Unit.

Once a baseline of twelve months has been established, linear cost savings and efficiency analyses by customer will be possible. Since Omnicell equipment is not fully installed in the entire facility, a recommendation for future research is to compare HMEDDAC customers with Omnicell to those without Omnicell. One method of accomplishing the analysis is to compare the percentage of increasing supply expenses in proportion to workload between the non-Omnicell customers and Omnicell customers.

Accordingly, this will demonstrate whether Omnicell continues to be a good investment and is yielding increased cost savings over those customers without Omnicell.

To assist the customers without Omnicell equipment in developing similar supply management efficiencies, the Logistics Division should train the customers without Omnicell to create par levels and specific reorder points on their shelves so that they can order supplies manually, similar to Omnicell's automated method. By May 2005, HMEDDAC will be fielded with the upgraded release of DMLSS, version 3.05. Although available with the previous version of DMLSS, the implementation of version 3.05 will include hand held scanners and bar-coding technology so that the customers without Omnicell can order at the POU with more functionality than previously. Similar to inventory in Omnicell, shelf line items will have specific par levels and reorder points loaded into the scanners so that when a user inputs inventory levels, the scanner will order stock through an interface with DMLSS. However, unlike Omnicell, this technology will not track consumption or capture charges by patient.

The final recommendation for HMEDDAC is that it needs to more effectively employ Omnicell's interfacing capabilities. While patient lists are automatically uploaded into the inpatient wards' Omnicell cabinets when a patient is admitted, the OR and outpatient clinics' Omnicell cabinets have not received a good working interface with CHCS to list patients when they are scheduled for treatment at that clinic. Once this problem should be resolved, interfacing the outpatient clinics and the OR with patient name uploads will allow users to easily choose patients' names when assigning charges to patients. Currently, the OR and the outpatient clinics charge virtually 100% of consumption to floor stock; and the ER and inpatient wards scarcely assign consumption to patients. This is mostly the result of non-compliance as opposed to interfacing shortfalls. However, in order for the commander to have good information allowing him to make informed choices on which services and procedures to continue offering in the facility, users must assign supply consumption to specific patients so that Omnicell can record and report accurate costs per service, procedure, diagnosis, physician, patient, and patient day. Furthermore, if the outpatient clinics and same day surgery customers accurately assign charges to the patients through Omnicell, the Patient Administration Division may be able to use this documentation in the future to assist its billing office with outpatient itemized billing of allowable charges.

An additional interface which must be monitored on a regular basis is the Omnicell interface with DMLSS. Currently, the expense and consumption data from DMLSS and Omnicell's database differ considerably. Reasons for this discrepancy include: the DMLSS/Omnicell interface is not working properly, and updating is not occurring because no one is verifying proper interface functionality and cost updating between the DMLSS and Omnicell catalogs. While there may be several reasons for this phenomenon, it is clear that DMLSS' and Omnicell's cost information are not updating as they should. This unit cost discrepancy can be resolved through a working item master update (IMU) interface, between DMLSS' catalog and Omnicell's item master list, which updates the unit costs for each item in Omnicell as the price changes in DMLSS. As an additional measure, IMU batch testing should be performed regularly to verify that the catalogs and master charge lists for Omnicell and DMLSS are synchronized.

The majority of these recommendations can be managed by a dedicated Omnicell administrator who is responsible for the management and customer support of the

Omnicell database and equipment from an on-going, daily operational perspective. Beyond being experienced in supply chain management and logistical operations, the administrator must be proficient in the analysis of Omnicell's financial, operational, technical, and maintenance reports so that customers can realize operational efficiency improvements and cost savings from actions taken as a result of effective analyses. Furthermore, the administrator will have a technical understanding of the Omnicell equipment and database, possess functional and operational expertise in DMLSS, and have an understanding of the interface relationships and capabilities between Omnicell and the other systems within HMEDDAC.

Although this study concludes that Omnicell was a worthwhile investment for HMEDDAC, the BCA process and equipment purchase process must be improved within HMEDDAC. Analysis of the costs and benefits of new equipment should be considered prior to any capital investment. Although the executive committee has a process for approving and prioritizing equipment purchases, it must ensure that the requesting officials have conducted a business case analysis and communicated the results of the analysis to the executive committee prior to the equipment being placed on the priority list; however, the current HMEDDAC policy does not mandate any form of capital investment analysis when submitting equipment purchase requests. In the case of the Omnicell purchase, although the commander approved the purchase, the equipment had not been placed on the priority list; however, the last-minute availability of year-end funding allowed HMEDDAC to purchase the Omnicell equipment prior to performing an adequate capital investment analysis. The mandatory completion of a business case analysis, with the process established in a written policy, will prevent an equipment purchase request from being placed on the executive committee priority list until the analysis has been performed.

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Appendix A

Figure A1. Example Patient Billing by Payor Report

Omnicell™

Patient Billing By Payor Report

RPT023-R1

03/25/2005 15:02:45 Patient Billing By Payor Report Page 1

Date Range: 03/10/2005 12:00:00.00 AM thru 03/24/2005 11:59:59.99 PM
Rx Control Level(s): '0','1','2','3','4','5','6','S'
Charge Type: Billable and Non-Billable

Patient ID:
Patient Name:

Payor ID	Item ID	Total Qty	Item Description	Total Cost	Total Price
<None>					
	0158030485	6	GLOVES BIOGEL 8.5 1S	$ 7.86	$ 0.00
	0407005370	1	GLOVES SIZE 7 BROWN 1S	$ 2.14	$ 0.00
	0570022050	1	SOLUTION ANTI FOG 1S	$ 5.12	$ 0.00
	0570CATCH10G	1	ENDOCATCH CATCH10G	$ 81.62	$ 0.00
	0620896316	2	FOLEY TRAY	$ 18.10	$ 0.00
	0723305127	1	NEEDLE HYPO25G1.5IN100	$ 0.05	$ 0.00
	0723309604	1	SYRINGE 10CC 1S	$ 0.12	$ 0.00
	105525007050	1	SUCTION IRRIGATOR, STRYKER	$ 75.16	$ 0.00
	12330340309	1	LOTION KERI 2OZ #0309 UNSENTED	$ 0.36	$ 0.00
	2027	1	Morphine	$ 0.00	$ 0.00
	2299005DSG	2	GRASPER ENDO 5MM 33CM RATCHET	$ 230.26	$ 0.00
	22990355LD	1	5MM LONG TROCAR 355LD	$ 76.11	$ 0.00
	22990FDC81	1	KIT CHOLECYSTECTOMY 3S	$ 534.76	$ 0.00
	3158007731	1	SKIN ADH REMOVER	$ 43.62	$ 0.00
	328C84719009	1	INCENTIVE SPIROMETER	$ 4.90	$ 0.00
	3583001806	3	2X2 SPONGES 30 BXS	$ 0.14	$ 0.00
	3583006522	4	LAPS LARGE 18X18 1PG	$ 7.48	$ 0.00
	3583007318	3	RAYTEX 7318	$ 3.42	$ 0.00
	3842090142	7	GOWN X-LG 1S	$ 30.73	$ 0.00
	4218	1	Heparin	$ 0.00	$ 0.00
	4304030169	4	BAG BICHAZARD 1S	$ 1.72	$ 0.00
	4335260619	1	BENZOIN TINC SWAPS .5OZ 1S	$ 0.43	$ 0.00
	4352YND70261	2	PREP TRAY DRY	$ 8.30	$ 0.00
	4509001582	1	2" COBAN	$ 1.51	$ 0.00
	4509008630	1	DURAPREP	$ 6.46	$ 0.00
	4509015381	1	1" SILK TAPE	$ 0.67	$ 0.00
	450909505W	3	OPSITE-SMALL	$ 1.38	$ 0.00
	45090R1547	1	STERI STRIPS 1/2X4 50S	$ 1.21	$ 0.00
	4905H30010	1	CHUX	$ 0.10	$ 0.00

03/25/2005 15:02:45 **Patient Billing By Payor Report** Page 2

Date Range: 03/10/2005 12:00:00.00 AM thru 03/24/2005 11:59:59.99 PM
Rx Control Level(s): '0','1','2','3','4','5','6','S'
Charge Type: Billable and Non-Billable

Patient ID:
Patient Name:

Payor ID	Item ID	Total Qty	Item Description	Total Cost	Total Price
<None>					
	5283HNICU:0(	1	HEEL WARMER INFANT	$ 0.95	$ 0.00
	6005700088	2	WASHCLOTH DISP 50S	$ 0.07	$ 0.00
	603428D0207	1	INSUFFLATION TUBING	$ 8.35	$ 0.00
	603460D101	2	HAND TOWEL PACK	$ 14.06	$ 0.00
	6608E15526	5	BOVIE TIP, LONG	$ 23.10	$ 0.00
	6709H30507	1	EMESIS BASIN	$ 0.07	$ 0.00
	6996764310	1	ARM SLING	$ 4.35	$ 0.00
	MEF1ADD	2	Cefoxitin Add-a-vial	$ 0.00	$ 0.00
	P129249001	1	LAMP,HALOGEN,OR 1S	$ 54.30	$ 0.00
	SS00018	1	KEY ELEVATOR	$ 0.00	$ 0.00
			Totals for	**$ 1245.05**	**$ 0.00**
			Totals for Patient Stay:	**$ 1245.05**	**$ 0.00**

END OF REPORT

Omnicell™

Patient Billing By Payor Report

RPT028-R1

03/25/2005 15:02:09 Patient Billing By Payor Report Page 1

Date Range: 03/10/2005 12:00:00.00 AM thru 03/24/2005 11:59:59.99 PM
Rx Control Level(s): '0','1','2','3','4','5','6','S'
Charge Type: Billable and Non-Billable

Patient ID:
Patient Name:

Payor ID	Item ID	Total Qty	Item Description	Total Cost	Total Price
<None>					
	0158030480	3	GLOVES 8.0 BIOGEL 1S	$ 4.08	$ 0.00
	0407005375	2	GLOVES 7.5 BROWN 1S	$ 4.28	$ 0.00
	07052D7254	1	GLOVES 7.5 WHITE 1S	$ 0.48	$ 0.00
	07052D7255	1	GLOVES 8.0 WHITE 1S	$ 0.48	$ 0.00
	07075651930C	4	SUCTION 3000CC 1S	$ 9.52	$ 0.00
	0723309661	1	SYRINGE 20CC 1S	$ 0.28	$ 0.00
	0723371115	1	BLADE 15 1S	$ 0.33	$ 0.00
	0723405174	1	NEEDLE SPINAL18G 3" 100	$ 1.41	$ 0.00
	3583002554	1	WEBRIL 6IN	$ 2.71	$ 0.00
	3583009192	1	ABD PAD 1EA	$ 0.23	$ 0.00
	358381850815	1	NEEDLE HYPO 18G 1S	$ 0.05	$ 0.00
	3642089111	2	DRAPE HALFSHEET 77X44" 1S	$ 3.90	$ 0.00
	3642090142	2	GOWN X-LG 1S	$ 8.78	$ 0.00
	401	1	White Petrolatum	$ 0.00	$ 0.00
	4304000169	1	BAG BIOHAZARD 1S	$ 0.45	$ 0.00
	4335260619	1	BENZOIN TINC SWAPS .5OZ 1S	$ 0.43	$ 0.00
	4352376201	1	GLOVES 8.5 WHITE 1S	$ 0.34	$ 0.00
	45090R1546	1	STERI STRIPS 1/4X4 50S	$ 1.35	$ 0.00
	5898014477	1	GOLD PLUG	$ 22.59	$ 0.00
	5949SORB3000	5	ISOSORB (SOLIDIFIER) 3000 1S	$ 11.35	$ 0.00
	603460D101	2	HAND TOWEL PACK BLUE	$ 14.06	$ 0.00
	6515081374848	1	ARTHOCARE WAND 3.5MM 90DEGREE	$ 218.21	$ 0.00
	66080E7507	1	BOVIE PAD ADULT 1S	$ 3.95	$ 0.00
			Totals for	$ 309.26	$ 0.00
			Totals for Patient Stay:	$ 309.26	$ 0.00

Appendix B

Figure B1. Example Par vs. Usage Report

Omnicell™

Par vs. Usage Report

RPT027A-R1

02/28/2005 07:41:09 Par vs. Usage Report Date Range: 07/01/2004 12:00:00.00 AM thru 01/31/2005 11:59:59.99 PM Page 1

OmniSupplier: MHFP_SUP -- Family Practice Supply

Item ID: * -- (All)

Rx Control Level(s): 'S' Number of Days in Date Range: 215

Charge Type: Billable and Non-Billable

OmniSupplier: MHFP_SUP

Item ID	Item Name	Quantity Used	Average Unit Cost	Extended Cost	Par	R/O	C/L	Min[a]	Max[b]	Average Usage per: Transaction[c] Days	Average Usage per: Dt Range[d] Days
0394005500	CONDOM LATEX	209 ea	$0.09000000	$18.81	500	250	100	1	80	26.13	0.97
										8 [e]	
04075771115	TUBE DRAINAGE 5/8 200S	18 ea	$70.3000000	$1,265.40	20	10	5	3	15	9.00	0.08
										2 [e]	
07052D7251	SZ 6 STERILE GLOVE	15 ea	$0.46000000	$6.90	55	5	1	15	15	15.00	0.07
										1 [e]	
* 07052D7254	SZ 7.5 STERILE GLOVE	433 ea	$0.46254042	$200.28	55	5	1	2	55	27.06	2.01
Days at C/L: 8		Days at Stockout: 8								16 [e]	
* 07052D7255	SZ 8 STERILE GLOVE	126 ea	$1.21571429	$153.18	55	5	1	4	40	18.00	0.59
Days at C/L: 2		Days at Stockout: 2								7 [e]	
0707010391	3CC SYRINGE W/25G NEEDLE	427 ea	$0.53271663	$227.47	40	20	15	1	20	15.25	1.99
Days at C/L: 27		Days at Stockout: 17								28 [e]	
0723305106	30G NEEDLE	1052 ea	$0.87448669	$919.96	100	50	10	2	100	30.06	4.89
Days at C/L: 3		Days at Stockout: 3								35 [e]	

[a]Min = minimum usage per transaction day [b]Max = maximum usage per transaction day

[c]Average Usage per Transaction Days = quantity used divided by transaction days, i.e., the number of days during the date range that transactions actually occurred

[d]Average Usage per Date Range Days = quantity used divided by number of days in the specified date range

[e]Number of Transaction Days * = Destock transaction (K)

Appendix C

Figure C1. Example Transactions by Date Report

Omnicell™

Transactions by Date

Rpt001

04/07/2005 12:35:13 **Transactions by Date**

Date Range: 01/01/2005 12:00:00.00 AM thru 01/31/2005 11:59:59.99 PM

Page 1

OmniSupplier: MHMB_SUP – Mother/Baby Supply
Rx Control Level(s): 'S'
Transfer Type(s): 'I','R','S','O','K','D','P','E','N','W','X','Q','C','M','A','Z'

OmniSupplier: MHMB_SUP – Mother/Baby Supply

Date/Time	Item Description [1]	Item ID [1]	Type	Qty	B/N Charge ID [2]	Patient Name	User Name
01/01 12:52A	PPV BAG NEONATE/INFANT	5929166300G	I	1ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	MASK ORONASAL INF 20S	6697005220	I	1ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	FOLEY	0620898318	I	2ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	DIAPER HUGG 6-14LB160S	3642052121	I	10ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	CAP INFANT PINK	4352T211434P	I	3ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	CAP INFANT BLUE	4352T211434B	I	3ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	DELEE SUCTION	358388257360	I	2ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:52A	WASHCLOTH DISP 50S	6005700088	I	1pg	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:54A	CHUX	4905H30010	I	1pg	B	(floor Charge)	Maxwell, K, Cpl
01/01 12:54A	MATERNITY PAD	3583002022	I	1ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 1:15A	INC SPIROMETER	328084719009	I	1ea	B	(floor Charge)	Bacolod, D. Cpl
01/01 5:24A	1500CC SUCTION CANNISTER	71-1171	I	1ea	B	(floor Charge)	Peterson, M, Pvz
01/01 5:24A	DELEE SUCTION	358388257360	I	1ea	B	(floor Charge)	Peterson, M, Pvz
01/01 5:24A	FOLEY	0620898318	D	-3ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 5:24A	FOLEY	0620898318	I	7ea	B	(floor Charge)	Maxwell, K, Cpl
01/01 5:55A	POSTPARTUM ICE PACK	3215006300	I	5ea	B	(floor Charge)	Stewart, A, Cpt
01/01 5:59A	ALCOHOL PAD	4725C69900	I	1bx	B	(floor Charge)	Stewart, A, Cpt
01/01 9:11A	(null transaction)	*NULL*	N NA	0ea	N	(floor Charge)	Anderson, T, Sgt
01/01 9:19A	2" PLASTIC TAPE	4509015272	I	1ea	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:19A	1" TAPE	4509015271	I	1ea	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:19A	GLOVES SURG SZ 7 WHITE 200S	07052D7253	I	2ea	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:24A	ALCOHOL PAD	4725C69900	I	1bx	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:24A	DELEE SUCTION	358388257360	I	3ea	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:24A	DIAPER HUGG 6-14LB160S	3642052121	I	40ea	B	(floor Charge)	Stohler, Robert Cpl
01/01 9:24A	SCRUBS W/O SOAP	0723371603	I	2ea	B	(floor Charge)	Stohler, Robert Cpl

Information Key: Please refer to the "Report Abbreviation Key" Opperational Report for a list of all Transfer Types, Misc Codes, Null Types and Inactive Access Types

Footnotes: 1 = Item name and ID fields will display Chargeable Procedure name and ID for all transactions of Type = 'P'

2 = Charge ID field will display Witness name for all Waste Transactions

04/07/2005 12:35:13 **Transactions by Date**

Date Range: 01/01/2005 12:00:00.00 AM thru 01/31/2005 11:59:59.99 PM

OmniSupplier: MHMB_SUP – Mother/Baby Supply

Rx Control Level(s): 'S'

Transfer Type(s): 'I','R','S','O','K','D','P','E','N','W','X','Q','C','M','A','Z'

OmniSupplier: MHMB_SUP -- Mother/Baby Supply

Date/Time	Item Description [1]	Item ID [1]	Type	Qty	B/N Charge ID [2]	Patient Name	User Name
01/31 9:40P	MATERNITY PANTIES	4905SBXL1002	I	1ea	B	[redacted]	Pelly, M
01/31 11:09P	FORMULA W/IRON SIMILAC	8940081300005	I	8ea	B		Leblanc, R
01/31 11:09P	NIPPLE UNIT PED 250S	6530011642947	I	12ea	B		Leblanc, R
01/31 11:19P	CAVIWIPES 1S	4399131100	I	1ea	B		Leblanc, R
01/31 11:53P	HUMIDIFIER DISP. 50S	3280003230	I	2ea	B	(floor Charge)	Leblanc, R
01/31 11:53P	MASK ORONASAL INF 20S	6697005220	I	2ea	B	(floor Charge)	Leblanc, R
01/31 11:53P	MASK OXIGEN NON/REBR	0707001203	I	2ea	B	(floor Charge)	Leblanc, R
01/31 11:58P	CHUX	4905H30010	I	4pg	B	(floor Charge)	Leblanc, R
01/31 11:58P	WASHCLOTH DISP 50S	6005700088	I	1pg	B	(floor Charge)	Leblanc, R
01/31 11:58P	EMESIS BASIN	6709H30507	I	8ea	B	(floor Charge)	Leblanc, R

2100 Transactions for MHMB_SUP – Mother/Baby Supply

Net Total Quantity: -337

Absolute Total Quantity: 14399

Transactions By Date Summary

2100 Total Transactions for this report

Net Grand Total Quantity: -337

Absolute Grand Total Quantity: 14399

END OF REPORT

Information Key: Please refer to the "Report Abbreviation Key" Opperational Report for a list of all Transfer Types, Misc Codes, Null Types and Inactive Access Types

Footnotes: 1 = Item name and ID fields will display Chargeable Procedure name and ID for all transactions of Type = 'P'

2 = Charge ID field will display Witness name for all Waste Transactions

Appendix D

Some Reports Available From Omnicell Database

Consumption Cost per OmniSupplier and Cost Center: Can be used to add cost center volume in units of service (patient days, visits, or cases) to track cost per unit of service over time.

Consumption by Site per Hospital Area and Cost Center: Can be used to add cost center volume in units of service (patient days, visits, or cases) to track cost per unit of service over time.

Discrepancy Transactions per OmniSupplier / Cost Center: Can be used to identify trends that may indicate abuse. Should compare this report with Null Transaction report to demonstrate cost of non-compliance

Inventory Aging: Can be used to demonstrate obsolescence to users and to help negotiate excess inventory reductions that can yield space to higher moving products.

Inventory Cost at PAR: With properly monitored cycle counts, can be used for periodic inventory valuation or as a gauge against physical counts.

Lost Charge Summary per OmniSupplier / Cost Center: Shows billable items that did not get allocated to patients by virtue of use of "Floor Charge" or from discrepancies

Master Item List: Should be used to identify database faults then expose the extent of the faults with custom Foxfire reports. Should also be used to check DMLSS interface and updating of supply costs

Par vs. Usage: Can be used to study performance of an individual OmniSupplier, analyze high-moving items, identify non-moving items and calculate ROP and PAR levels based on usage. Can also use report to affect and value potential inventory changes and to find customer service improvement targets by compiling stock out lists by item by OmniSupplier.

Item Expiration Tracking: If pharmacy inputs expiration dates of medications when stocking the Omnicell cabinets, this report can track the expiration dates of the medications stocked within the cabinets.

Null Transactions: Can be used to identify patterns of potential abuse and to award excellent compliance.

Transactions by Date: Can be used to analyze user behavior, prepare lost charge and revenue reports by user, by area, by OmniSupplier and by date range. Should use on a monthly basis to compare what should have been billed with what was actually billed.